THE EARNINGS OF ASIAN COMPUTER SCIENTISTS AND ENGINEERS IN THE UNITED STATES

A Dissertation
Presented to
The Academic Faculty

by

Yu Tao

In Partial Fulfillment
of the Requirements for the Degree
History and Sociology of Technology and Science in the
School of History, Technology, and Society

Georgia Institute of Technology
August 2009

THE EARNINGS OF ASIAN COMPUTER SCIENTISTS AND ENGINEERS IN THE UNITED STATES

Approved by:

Dr. Willie Pearson, Jr., Advisor
School of History, Technology, and Society
Georgia Institute of Technology

Dr. Philip Shapira
School of Public Policy
Georgia Institute of Technology
Manchester Business School

Dr. Raymond Wong
Division of Social Science
Hong Kong University of Science and Technology

Dr. Amanda Damarin
School of History, Technology, and Society
Georgia Institute of Technology

Dr. Wenda Bauchspies
School of History, Technology, and Society
Georgia Institute of Technology

Date Approved: June 19, 2009

ACKNOWLEDGEMENTS

I am deeply indebted to my advisor and mentor, Prof. Willie Pearson, Jr., for his mentoring, help, and support during my Ph.D. study. I would also like to express my sincere thanks to other dissertation committee members, Prof. Amanda Damarin, Prof. Philip Shapira, Prof. Wenda Bauchspies, and Prof. Raymond Wong for their time in serving on my dissertation committee and their insightful comments. In addition, I would like to thank the faculty of the School of History, Technology, and Society at Georgia Tech, especially Prof. Ron Bayor, Prof. Hanchao Lu, and Prof. John Krige, for their comments on and all kinds of supports to my research. I also thank the Walter B. Jones Foundation at Georgia Tech for partially supporting my dissertation. Last but not least, I wish to thank my mother, husband, relatives, and friends, without whose guidance and support I would not be able to finish this dissertation and my Ph.D. study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAAS	American Association for the Advancement of Science
AAUP	American Association of University Professors
ACS	American Chemical Society
COSEPUP	Committee on Science, Engineering, and Public Policy
CPST	Commission on Professionals in Science and Technology
HBCU	Historically Black Colleges and Universities
NRC	National Research Council
NSB	National Science Board
NSCG	National Survey of College Graduates
NSF	National Science Foundation
S&E	science and engineering

SUMMARY

While Asians are overrepresented in science and engineering (S&E), they receive limited scholarly attention in sociology of science. To fill the knowledge gap about this understudied group, this study examines the effects of race, nativity, degree origin, gender, field, employment sector, and national origin on the annualized earnings of Asian computer scientists and engineers working in the U.S.

To understand the above effects, this study uses descriptive analyses and quantile regressions. Data are derived from the National Survey of College Graduates (NSCG) conducted by the National Science Foundation. To track the changes of the above effects over time, this study uses 1993 and 2003 NSCG data.

Using quantile regression, this study has the following major findings. First, race and nativity had some statistically significant effects on the earnings of Asian computer scientists and engineers in 1993 at both 90th and 50th quantiles. The race effect disappeared in 2003, and the nativity effect disappeared with an exception at the 50th quantile. Degree origin had a statistically significant effect in 1993 in some cases at the 90th quantile but across gender, field, and two employment sectors at the 50th quantile. While this effect existed in 1993, it disappeared in 2003 except among engineers and in educational institutions at the 50th quantile.

Second, in terms of gender differences in earnings, all the four women's groups, namely, white, Asian American, U.S.-educated immigrant, and Asian-educated immigrant women, earned less than their male counterparts in either 1993 or 2003 at either the 50th or the 90th quantile. In addition, U.S.-educated immigrant women suffered

from the double bind effect, or being disadvantaged due to both their gender and race, at the 50th quantile.

Third, computer scientists earned slightly more than their engineer counterparts in both years at both quantiles. Fourth, in terms of employment sector differences, educational institutions and state/local government paid less than industry in both 1993 and 2003 at both quantiles. Federal government, which paid comparable workers less than industry in 1993, eliminated the gap in 2003 at the 50th quantile but not at the 90th quantile.

Finally, when disaggregating U.S.-and Asian-educated immigrants by national origin, this study finds that a few but not all nationality groups, including the Chinese, Filipinos, the Vietnamese, Koreans, and the Taiwanese, suffered from earning disadvantages in 1993 or 2003 at either quantile. In addition, the findings at different quantiles suggest that the earnings of workers in the upper tail (90th quantile) are less influenced by their personal or employment characteristics that have been examined in this study than those at the median (50th quantile). In other words, workers of different backgrounds, such as race, nativity, degree origin, gender, etc., in the upper tail are closer to each other in earnings than those at the median.

Overall, the findings partly confirm the structural arguments that some groups, notably women, racial/ethnic minorities, and immigrants, are disadvantaged in the U.S. workplace. The degree origin effect in 1993 could be due to the lower quality of degrees obtained from Asian higher education institutions and to the marginalized structural positions of Asian-educated immigrants in the American society. The disappearance of such an effect in 2003 could be due to the interactions between structural forces and human capital. The change of the effect of human capital has to be placed in a context of globalization and the resulting structural changes in various aspects, such as the improvement in higher education in Asia and changes in immigration policies in the U.S.

CHAPTER 1

INTRODUCTION

A number of studies have examined the status of Asians in the United States (U.S.).[1] Most of these studies examine Asians in all occupations and with all levels of education. Some find that Asians, compared with whites and other racial groups, have high educational attainment, are overrepresented among professional workers, and achieve high socioeconomic status. As a result, Asians are often labeled as a "model minority." Some earlier studies show that native-born Asian American men and women as a whole and of some ethnicities have achieved earning parity with their white counterparts who have comparable education and other demographic characteristics (Chiswick 1983; Iceland 1999).

However, other studies find this label problematic in that native- and foreign-born Asians with education comparable to whites do not always earn as much as whites, and there are great internal variations among Asians. Sharpe and Abdel-Ghany (2006) report that compared with their white counterparts, Asian Indian workers do not earn statistically significantly less or more, and Japanese earn more. But Chinese, Filipino, Japanese, Korean, and Vietnamese workers earn less than comparable whites. This study and other studies (*e.g.*, Barringer, Takeuchi, and Xenos 1990) remind readers of the high heterogeneity among Asian Americans. Consider that Asians are overrepresented in both successful professional and below-the-poverty-line populations. In addition, each ethnicity (such as the Chinese, Indians, and the Japanese) has its unique language, culture, and economic status (Xie and Goyette 2004). Thus, studies of Asians in the U.S. should not treat them as a whole but examine their internal differences.

In the science and engineering (S&E) fields, National Science Board (NSB) (2008) reports that Asians are overrepresented in terms of degree production and workforce participation, especially in fields such as computer science and engineering and at the doctoral level. In 2003, Asian U.S. citizens and immigrants received 6,632 S&E doctorates, or about 26% of all S&E doctorates (Burrelli 2006). Asians choose occupations such as professionals (*e.g.,* scientists, engineers, doctors) because they perceive these fields as having relatively objective and universalistic evaluation criteria. In addition, these occupations provide better financial returns than many other occupations. Thus, in S&E occupations, Asians can maximize their opportunities of upward social mobility (Xie and Goyette 2003). Yet, partly due to their overrepresentation, studies of scientists and engineers typically neglect Asians. Most scholarly attention in this line has been paid to white women and, to a limited extent, racial/ethnic minorities, such as African Americans and Hispanics.

Examining the earnings of Asian computer scientists and engineers provides an excellent opportunity to fill gaps in knowledge concerning the understudied Asian S&E workers in two fields. Both computer sciences and engineering are relatively lucrative fields, which is partly due to the high demand and the strategic role of information and other technologies to economic development, as National Research Council (NRC) (2001) reports. Clearly, the growth of the S&E workforce has been faster than that of others for decades (NSB 2008). In 2003, among all bachelor’s and master’s degree holders in S&E and health fields, those who graduated in 2001 and 2002 with degrees in engineering and computer sciences earned the highest salaries (Tsapogas 2005). The investigation of Asians' earnings in these two occupations allows readers to understand how Asians fare financially, compared with whites and with each other, in fields that are well-paid and where Asians are overrepresented. In addition, both fields are male-dominated. They provide an opportunity of examining how Asian women fare compared with other racial and gender groups in fields where Asians as a whole are overrepresented but women as a whole are underrepresented.

This study examines the impact of different personal characteristics on earnings. It also reveals the internal variations of Asians in the U.S. from the perspectives of scientists and engineers. Unlike some previous studies that focus on a certain time period, this study tracks the changes of earnings from 1993 to 2003. The data used in this study are not longitudinal. In other words, the 1993 and 2003 data do not cover exactly the same sample. However, the analysis of the effects of personal characteristics on earnings in the two years still can show us the changes.

This dissertation is organized into eight chapters. The next chapter, Chapter 2, examines theoretical frameworks and reviews related literature. The chapter discusses structural perspectives and the human capital theory, followed by a synthesis of the two theoretical frameworks. Then, it reviews previous studies of Asians, women and minorities (mostly white women and minority men), minority women, and immigrants in S&E in the U.S. The chapter also points out the limitations of earlier studies.

Chapter 3 develops hypotheses based on the literature. Chapter 4 discusses methodologies for this study. It discusses data and the analytical approach of this study. Notably, Asians are divided into three groups based on their nativity and the origin of the highest degree (or degree origin): 1) U.S.-born, U.S.-educated Asian Americans; 2) Asian-born, U.S.-educated Asian immigrants; and 3) Asian-born, Asian-educated Asian immigrants.

Chapter 5 reports and analyzes the demographic characteristics of Asian computer scientists and engineers in the sample. The demographic characteristics include the number and share of whites and Asians of each category in the sample and their personal, educational, and employment characteristics. The chapter also analyzes the earnings of whites and the three groups of Asian computer scientists and engineers by gender, degree, and field in 1993 and 2003.

Chapter 6 reports and analyzes quantile regression results, net of other factors, regarding the effects of race, nativity, and degree origin, and differences due to gender, field, employment sector, and national origin. The first section examines the effects of race, nativity, and the origin of the highest degree on the earnings of Asian computer scientists and engineers. The second section examines gender differences in the effects of the above three factors and in earnings by race. The third section looks at the field differences in the effects of the three factors as well as earning differences by field. The fourth section examines sector differences in the effects of the above three factors and earning differences by employment sector. All the sections in this chapter tracks changes from 1993 to 2003.

Chapter 7 explains the findings, compares them with those of previous studies, and indicates how the theoretical frameworks can explain the findings. Chapter 8 summaries the findings and analyzes policy and research implications. Now I turn to Chapter 2, which addresses theoretical frameworks and reviews relevant literature.

CHAPTER 2

THEORETICAL FRAMWORKS AND LITERATURE REVIEW

This chapter first addresses the theoretical perspectives that may explain factors influencing the earnings of Asian scientists and engineers. They include structural perspectives and region-specific human capital. Then, this chapter examines the literature that addresses the career advancement of Asians, gender and race, the intersection of race and gender, and immigrants in S&E. It also discusses the implications of the literature for Asians who are minorities and Asian women who are members of two minority groups (being Asian and women) in S&E. Finally, it discusses the limitations of the literature.

2.1 Theoretical Perspectives

2.1.1 Structural Perspectives

Structures in stratification studies refer to various aspects of social behaviors and relationships. Homans (1975) summarizes the various aspects of the structure that earlier authors examined. First, the structure infers endured or persistent social behaviors or relationships. For instance, the class structure represents an endured relationship, and it is more persistent than other social relationships or behaviors that can be easily changed. A second and related point is that the structure is fundamental and less subject to change. It is likely due to its large size, comprising several units, or due to the fact that the structure is somehow hidden. Third, the structure is a social whole composed of interdependent parts. To some sociologists, the interdependence of the parts is why the structure is persistent and hard to change. Fourth, the whole is larger than the sum of the parts. In short, structure perspectives emphasize causes and constraints that are not purely resting on beliefs, norms, and values or purely individual qualities and characteristics. The structure is the fundamental factor that determines a group’s behaviors and attitudes towards other groups and shapes their relationships in their lives and work. However, Homans criticizes that the various definitions of the structure do not reveal how researchers should study it. Based on Boudon’s (1971) framework, Homans proposes a framework that contains three components to understand how the structure works: 1) general propositions of a social phenomenon in conjunction with 2) the structure will lead to 3) further differences in behaviors. For instance, the general propositions about marriage in conjunction with the structure, such as rules that classify people into different groups, can lead to the types of marriage, or rules that allow certain groups to marry or prevent them from marrying other groups, in a society. According to Homans, this model can explain why people in different structural positions further differentiate their behaviors, to the extent of conforming to group norms. The third element, further differences in behaviors, may also become structural in the sense of being persistent. In a more recent study, Smith (2005) reviews studies that test structural theories from both qualitative and quantitative perspectives. He reports a gap between theoretical framing and empirical testing. Most structural theory studies do not form their theories based on empirical studies or test their theories against empirical data and thus remain speculative. Those that start with empirical observations and combine them with general propositions can lead to new theoretical implications regarding the structure. More specifically, the latter starts with analyzing empirical data, further develop or reformulate the theory, and retest it on new data. According to Smith, this data-first form of structural theorizing can tighten the linkage between research and theorizing and enhance our research.

Baron and Bielby (1980) assert that structures exist at five levels. They include 1) societal (the unit of analysis: economy); 2) institutional (market, industry); 3) organizational (firm); 4) role (job); 5) individual (worker). Structures at various levels play a role in contributing to inequality. The different achievement of groups can be due to the differences in class, labor market conditions, organizational size, the demand for specific skills, or human capital. Baron and Bielby argue for "bringing the firms back in," suggesting that researchers should examine the structure at the firm level because firms are where macro (*e.g.,* societal, economic, political) and micro (*e.g.,* job-level or individual-level) forces meet and affect work. Before Baron and Bielby, structural scholars tended to ignore firm-level studies. Reskin, McBrier, and Kmec (1999) review the literature of the sex and race composition in firms since 1980 and conclude that the demographic composition of an organization can serve as a structure for analysis because its effects are larger than the aggregated effects of the behaviors or attitudes of its members.

This study discusses theories and studies that test structural theories primarily at the societal and organizational levels. In other words, this study analyzes structural theories regarding racial/ethnic minorities in the U.S. society and women and racial/ethnic minorities in the U.S. workplace.

2.1.1.1 The Structure at the Societal Level: Racial/Ethnic Minorities in the U.S.

At the societal level, racial and ethnic minorities are structurally disadvantaged. Li (1988), of a Marxian tradition, argues that in a capitalist society, inequality exists based on class relations. Yet, other divisions can further divide the society. Racial/ethnic divisions ensure that menial jobs are done by racial/ethnic members who are socially defined as inferior. In the capitalist society, race and ethnicity can be used to explain the different status of groups—they serve as an asset for those who control privileged positions but as a liability for those who are oppressed and discriminated against.

Feagin (2006) argues that the U.S. society features a white-to-black oppression. People of color receive systematic racism. It is systematic in that racist treatment exists everywhere in everyday life, and it has existed not only historically (in the time of slavery and legal racial segregation for African Americans and land theft for American Indians) but also contemporarily (covert racism for all minorities). In the contemporary context, systematic racism is evidenced by the significant imbalance of wealth between average white and minority families, different access to opportunities in the workplace, residential segregation, and hostility that minorities receive in the other aspects of their economic and social lives. The white racial framing involves several procedures. They include first, stereotyping, such as characterizing African Americans as less intelligent, lazy, and criminous. Second, whites perpetuate these stereotypes. Third, they take discriminatory actions. In addition, the white-on-black oppression has been transferred to other people of color, such as the recent Latin American and Asian immigrants, who have suffered from negative stereotypes and been referred to as foreign, alien, and threatening to the American society.

Chou and Feagin (2008) argue that the systematic racism argument regards white oppression as foundational and persisting in the American society. From the beginning, whites with power have benefited their own racial group through designing and maintaining the country's economic, political, and social institutions. Whites have maintained a racial hierarchy, in which they are at the highly privileged end, blacks at the unprivileged end, and other minorities somewhere in between. Numerous racial institutions, such as government, also help to maintain the racial hierarchy.

Feagin's theoretical framework of systematic racism can explain Asian Americans' experience in the American society. Asians have a long history of being oppressed in the U.S. For instance, in the 19th century, the Chinese were stereotyped as "alien," "docile," "dirty," and "dangerous," and they were denied citizenship. During WWII, Japanese Americans were imprisoned into concentration camps (Chou and Feagin 2008). Based on in-depth interviews with 43 Asian/Pacific Islander Americans from 2005 to 2007, Chou and Feagin report that Asians in the U.S. experience discriminations and resulting violent treatments in public space, including hate crimes (being attacked or even killed for being Asian), harassment on public transportation vehicles (being attacked by racist remarks or behaviors), discrimination while shopping (being suspicious of stealing and not being helped when looking for something), and more. This kind of racist treatment is also true in schools and the workplace where they feel isolated and neglected for their contributions and face barriers even with all their achievements. Specifically in the workplace, Asians experience a glass ceiling, and they feel that they have to be much better than their white peers who are less qualified in order to get promoted. Oftentimes, Asians find it very hard to achieve a high-level position, even when they are overqualified (Chou and Feagin 2008).

Although statistics show that Asians have achieved socioeconomic success at the same level as whites and can serve as the "model minority," this concept masks important barriers that Asians face. For instance, Asians are overeducated for their positions in order to achieve economic parity white whites, their high educational attainment does not lead to an earning parity with whites, and great internal variations in economic and academic achievement exist among them (Chou and Feagin 2008; Hirschman and Wong 1984; Barringer et al. 1990; Varma 2006).

According to the systematic racism theory, the “model minority” concept was socially constructed by white Americans in response to the protests against discrimination from African American and Mexican American protests in the mid-1960s. The whites created this concept to allege that all minorities could fulfill their American dream by working as hard as Japanese and Chinese Americans. Nevertheless, Chou and Feagin find that although Asian Americans experience racism every day, many of them are not aware that the white hostility is structural and systemic because it is rarely studied (Chou and Feagin 2008).

In science, which is perceived as being more objective than other fields, Asian scientists and engineers are not free of concerns about being discriminated against or being marginalized. In national labs, Asian scientists became more concerned after the Lee incident (Glanz 2000). Wen Ho Lee was accused of the mishandling of nuclear secrets at the Los Alamos National Lab and was arrested in 1999. As a result, fewer Asians applied for positions in federal labs, and the number of Asian-born or Asian American scientists in national weapons labs dwindled. For instance, at Los Alamos, the average number of Asian applicants, whom committees granted formal reviews, was 28 in 1998 and 1999, but in 2000, the number decreased to three. Similarly at Sandia and Livermore National Labs, the numbers declined from 21 in 1998 to three in 2000. In addition, at the three labs combined, postdoc appointments of Asians and Asian Americans fell from 14% to 7% during the period (Glanz 2000).

The above theories suggest that a racial hierarchy exists, and racial/ethnic minorities are oppressed and marginalized. This has an implication to the earning status of Asians in the contemporary context: because they are marginalized in the American society, they are likely to be given less desired jobs. When their education enables them to take the same positions as whites, they may still not receive the same level of financial returns to their education and/or achieve the same level of advancement in the workplace as whites do.

2.1.1.2 Organizational Structures: Sex and Racial Segregation

In addition to the structure at the societal level, the one at the organizational level also favor certain groups over others. Women and racial/ethnic minorities tend to be paid less than men and whites, respectively. An important aspect of the inequality at the organizational level is the sex and racial segregation in the workplace. Segregation exists at different levels, including occupational, job, and establishment levels (Padavic and Reskin 2002). Two major theories, queuing theory and devaluation theory, have examined the causes of sex and racial segregation. Unfortunately, studies addressing and testing these theories tend to focus on women and some minority groups, especially African Americans and Latinos, but not much on Asians. However, the findings may inform us of the influence of structures on Asian workers as well.

Queuing Theory The first theory is the queuing theory. Thurow (1975) first introduced the idea of labor queues. He argues that when competing for jobs, individuals do not compete on the basis of lowest acceptable wages but relative costs of being trained to fulfill the requirements of the job. This model assumes that skills necessary for the job are not obtained before but after hiring. In other words, employers rank workers based on some background characteristics that can determine the costs of training. These background characteristics include workers' education, sex, age, personal habits, etc. Employers choose from the top of the labor queues, and the best worker whose training costs are the lowest gets the job. Subjective discrimination can play a role in the labor queue in that if employers discriminate against a certain group, such as blacks, then blacks will be lower in the labor queue than they otherwise could be.

Based on Thurow's theory, Reskin and Roos (1990) argue that in addition to the employer ranking of workers, workers also have a ranking of jobs. Based on this argument, there is a matching procedure, in which the highest-ranked worker gets the best job, and the lowest-ranked worker gets the job that others reject. On the one hand, employers rank workers in the "labor queues" based on workers' skills and training, or the proxies for productivity, as well as other aspects of workers, such as their race and sex. Employers hire workers from high in the labor queue or the workers that best meet their requirements. On the other hand, workers rank jobs according to what the jobs can offer to them, and they accept best jobs that are available to them in "job queues". The queuing theory assumes low payment and disadvantages in other aspects for women and minorities because they are low in the labor queues, and they do not have access to highly-paid positions and the appropriate bargaining power.

In this theory, both men and women respond to the demand for their labor in better occupations or positions. Men and whites rank high and are often recruited into positions or occupations that are best paid. However, when better jobs become available, they will leave current jobs for the better ones. At this time, the shortage of workers in the less desired jobs forces employers to recruit workers down at the labor queues, or women and minorities, who tend to respond to this change by leaving their current jobs for the better jobs available to them. This is true within and across various occupations, ranging from computer programmers to real estate agents. Women in sex-stereotyped occupations or in the labor force as a whole are ready to respond to the demand in better jobs or previously male-dominated occupations (Reskin and Roos 1990).

More recent studies find that some jobs are associated with certain races/ ethnicities. Generally speaking, employers would judge the appropriateness of a job for minority workers. Kaufman (2002) finds that employers tend to stereotype highly skilled work as “inappropriate” for women and blacks, who are, at the same time, stereotyped as less qualified. But work with subservient tasks, poor working conditions, and low pay is stereotyped as “appropriate” for them. These processes place women and blacks low at the labor queue for skilled jobs. However, Kaufman also finds that growth reduces the negative effect of stereotyping. In high-skill positions, the representation of women and blacks increases with growth, but at low-skill positions, their representation decreases with growth. While a shortage of skilled workers makes a worker’s gender and race less important than skills, a lack of skill constraint leads employers to favor the group that they prefer, or white men.

Devaluation Theory Unlike the queuing theory that argues that women and minorities earn less because they are low in the labor queues and can obtain less desirable jobs, the devaluation theory argues that women and minorities are paid less because their positions and skills are associated with them (England 1992). Employers treat jobs mostly done by women as low-skilled and being less valuable. As a result, they pay jobs that are dominated by women workers less than jobs that require comparable skills but are dominated by men.

Consistent with this line of arguments, research in sex composition has shown that skills that are assumed to be associated with female and percent female in an occupation influence the earnings of both male and female workers in the occupation. For instance, Kilbourne et al. (1994) find that net of other factors, the nurturant skills that are associated with women is negatively associated with wages. One unit of increase in the nurturant social skills that an occupation requires leads to over 2% loss in men's wages and 4% in women's wages. In addition, an occupation's percentage female is also negatively related to both men's and women's wages but larger for the latter. England (2006) summarizes research that takes different units of analysis, including occupations, individuals, and jobs. At the occupational level, percent female is negatively associated with both men and women workers' wages. At the individual level, the person earns less when moving from a more male-dominated to a more female-dominated occupation. At the job level, for jobs with the same level of job evaluation, meaning that these jobs demand comparable skills and working conditions, workers in predominately female jobs earn less than those in predominately male jobs. England also proposes a possible mechanism that is responsible for the devaluation of female-dominated jobs and occupations. This mechanism starts at a certain time point, usually when the firm is newly formed or being significantly restructured. Managers or other decision makers are influenced by their discrimination when deciding the wages for various jobs. Over time, the wages become institutionalized when bureaucratic inertia takes place, and it becomes hard to change. In the time of changing wages to female occupations, male workers' actions may lead to a larger increase for men's jobs than that for women's jobs. In the meantime, the market forces an organization, no matter whether it has gender bias or not, to pay male occupations or jobs more than the female equivalents. Without new legislation or collective action, the devaluing mechanism will keep wages lower in female-dominated jobs.

However, the devaluation of occupations works differently for women than that for minorities. Reid (1998) analyzes the effects of percent white female, percent black female, percent Latina female, percent black male, and percent Latino male in an occupation on the earnings of these groups and white men. She finds that net of other factors, the percentage of one woman's group—white women—negatively influences the earnings of four groups, white men and women and black men and women. Net of other factors, each of the above four groups loses about 1 cent in hourly wages with a 1% increase in percent white women in an occupation. However, percent black and Latino women as well as percent black men do not have a significant effect on wages for all but white women (White women's earnings are negatively influenced by percent black and Latino female.). Further regression including the interaction terms of race/gender composition and geographic locations does not provide consistent findings that the higher proportions of racial/ethnic minorities in a region would lead to a greater devaluation of occupations due to the racial/ethnic composition. Thus, Reid concludes that the devaluation of an occupation for racial/ethnic minorities does not happen in the same manner as that for women.

More recent studies further distinguish the effect of devaluation at the job level from those at the occupation and establishment levels. Kmec (2003), using individual-level data from the Multi-City Study of Urban Inequality and establishment-level data from the Multi-City Telephone Employer Survey, examines the effects of the proportions of black, Latino, and Asian workers at the job, occupation, and establishment levels on wages. She does not find a significant effect at the local occupational level. Considering the fact that data are aggregated for three metropolitan areas (Atlanta, Boston, and Los Angeles), Kmec adds the interaction terms of city and workplace minority concentration, but these interaction terms are not statistically significant. At the establishment level, the proportion of Latino workers is negatively associated with wages. She argues that this relationship may be explained by employers' tendency of concentrating Latinos into low-wage and "dirty" establishments. At the job level, mostly black and mostly Latino jobs are negatively associated. Mostly black and mostly Latino jobs but not mostly Asian jobs pay workers lower than comparable mostly white jobs. The same results are found when Kmec limits the data to be non-professional, non-management workers. When Kmec includes the variables at all the job, the occupational, and the establishment levels into the regression model, only the effects at the job level—mostly black and mostly Latino jobs—are associated with lower payment. In other words, net of occupational and establishment-level minority concentration and other control variables, mostly black and mostly Latino jobs pay comparable workers (all workers, not just blacks or Latinos) 18% and 15% less, respectively, than mostly white jobs. As a result, job-level characteristics best measure the relationship between the concentration of minority workers (and which minority groups) and wages or the devaluation of jobs done mostly by minority workers.

Other studies have shown the effect of racial/ethnic segregation on the earnings of Asian Indian, Filipina, and non-Hispanic white women in the U.S. Torres Stone, Purkayastha, and Berdahl (2006) find that the percent Asian Indian of an occupation has a slight negative effect and percent Filipino has a positive effect on the earnings of these women workers. More specifically, occupational percent Asian Indian has a statistically significant, slightly negative effect on white women but not others, and occupational percent Filipino has a positive effect on the earnings of all the three women's groups but larger for Filipina and Asian Indians than whites (13%, 9%, and 4%, respectively).

In an effort to test whether and how the queuing, devaluation, and other theories explain the relationship between changes in occupational sex composition and in wages, England, Allison, and Wu (2007) examine the effects of the change in occupational sex composition and the change in pay on each other. Using longitudinal data, Current Population Surveys, on occupations in the U.S. from 1983 to 2001, they find no support that decreasing wages lead to the increasing women's representation in an occupation but find some support that the increasing female concentration in an occupation leads to a slight decrease in wages, and the wage decrease was larger for men than for women. In other words, they do not find support for the queuing theory but some modest support for the devaluation theory.

The queuing and devaluation theories have provided explanations for sex and racial segregation at work and the low payment of women and minorities from different perspectives. They may also be useful to explain women's and minorities' earnings in occupations in which they are not segregated. In other words, in science and engineering, predominately white and male fields, women and minorities may be lower at the job queues as well, and their work, which may be different from that of a white or a male who has the same job title as a scientist or an engineer, may also be devalued.

2.1.2 Region-Specific Human Capital

The human capital theory argues that the increase in earnings can be explained by human capital, or the investment in human beings, such as health, on-the-job training, education, and the migration of workers. The main components of human capital include early ability, knowledge and qualifications that are obtained through formal education, and skills and other qualifications acquired through on-the-job training. The investment in human beings can affect productivity, which brings about differences in wages (Becker 1993; Schultz 1961). Blundell et al. (1999) find that earning differences between high school graduates and college graduates can be explained by the differences in their education levels. In some developed Western economies, the average rate of return to an additional year of education is between 5% and 10%. In the age of human capital, the earning difference between high school graduates and college-educated workers is increasing. In the 1960s, the earning gap between them was about 50%, but in the turn of the 21st century, it rose to about 75% (Becker 2002). Yet, the relationship between human capital and earnings is not independent of other factors. Becker (1993) finds that the rate of return to education varies due to race, gender, and the geographic location: it is higher for urban, white, male, and college graduates than for rural, women, minority, and college dropouts.

Along this line, the origin of the human capital, which is more pertinent to this study, may lead to pay differentials. Human capital obtained in a foreign country or region may be valued and rewarded differently from that obtained in the U.S. educational system, a prestige ranked hierarchical system, in the U.S. workplace. Zeng and Xie (2004) find that Asians' earning disadvantages recorded in previous studies can be explained by the place of education rather than their race and nativity (U.S.- or foreign-born). Using the 1990 census and the 1993 National Survey of College Graduates data, they find that among all male Asian workers who are 25- to 44-year-old, non-disabled, and working full-time in the U.S, only those who finished education before coming to the U.S. earned significantly less—they earn 16% less due to their origin of education. Thus, foreign education rather than Asian race or foreign nativity contributes to Asians' earning disadvantages that are reported in previous literature. Zeng and Xie also find ethnic differences in financial returns to education among foreign-educated Asian immigrants. While education, experience, English skills, labor input, and residence are controlled for, while the Japanese earn 39% more than U.S.-born whites, other ethnic groups earn less (*e.g.*, Filipinos earned 23% less). The authors attribute the earning advantage of the foreign-educated Japanese to their high educational quality and their concentration in management positions. But for all other ethnicities, foreign education leads to an earning disadvantage to their white counterparts.

Similarly, Bratsberg and Ragan (2002) report that in the U.S., among male immigrant workers, the wages are higher for immigrants with U.S. education than those without. Among those who do not receive any U.S. education, immigrants from developed countries (measured by GDP) and English-speaking countries receive higher financial returns to each additional year of schooling (especially if over 11 years of schooling) than those from less developed and non-English speaking countries. The above results can be explained by the differences in the education systems of the two categories because education systems in developed countries are more similar to that in the U.S. than those in less-developed regions. The first category of regions and countries include four Asian countries and areas (Japan, Hong Kong, Taiwan, and Singapore), Canada, United Kingdom, New Zealand, Australia, and Ireland, and Western and Northern Europe. The second category includes Central America (including Mexico); Asian countries except the above four; Northern Africa; and Eastern and Southern Europe.

The effect of human capital obtained outside the host country is not limited to the U.S. In Norway, Wiers-Jenssen and Try (2005) find that net of personal and other educational backgrounds, Norwegians (not immigrants) who graduated from foreign higher education institutions (at any degree level) are less likely to be employed by Norwegian employers and are more likely to be overeducated for their positions because domestic employers are more skeptical about their education or degrees. Once hired, however, graduates from foreign higher institutions earn more than those who graduated from Norwegian institutions. But this wage premium disappears when the type of employers is considered. Abroad graduates tend to be employed in private and international firms, where the pay is higher than in other types of employers.

In Canada, most adult refugees who worked in their home countries before moving to Canada as refugees experience downward mobility. Among those who found jobs in Canada, a large proportion of them have to work part-time or take temporary positions. Among professionals and managers, 40% are overqualified. Among clerical staff, sales, services, and technicians, 65% are overqualified. Among blue-collar workers, 56% are. Their downward occupational mobility is due to problems in getting their education and credentials recognized, lack of English proficiency, lack of reference or labor market knowledge, and employment-related discrimination (Krahn et al. 2000).

In the U.S. workplace, the human capital obtained in the U.S., as compared with that in other regions, may come with another advantage—a higher level of social capital that is helpful to find employment and other aspects of their careers. Bourdieu (1985) defines social capital as resources related to a network of relationships. In the relationship, individuals know each other and can trust each other. Coleman (1988) argues that social capital plays an important role in the creation of human capital. He finds that the social capital in family, for instance, the adult-children ratio (*e.g.,* two parents vs. single parent and one sibling vs. four siblings) and adult attention in the family (*e.g.,* mother's expectation of the child to go to college) influences the high school dropout rate. When the three factors are combined, the child from a two-parent, one-sibling family where the mother expects him/her to go to college has a dropout rate of 8.1%, and that from a single-parent, four-sibling family where the mother does not expect college has a dropout rate of 30.6%, leading to a 22.5% of difference. Furthermore, social capital outside the family, such as the number of times the child changed school, the type of school (public vs. private), the religious affiliation of the school, etc., have impacts. The characteristics of the community where people interact and establish relationships can influence the dropout rate of high school students. People's behaviors are influenced by social context but not just financial resources available to them.

In addition to family support, another consequence of social capital that is more relevant to this study is network-based benefits. Granovetter (1974) argues that weak ties, rather than strong ties, can bring to individuals valuable, exclusive information about and referral for employment. Burt (1992) argues that the "structural holes," which refers to the gaps between non-redundant contacts, or discrete groups of people or individuals with complementary resources or information, can bring useful information. The more structural holes one network provides an actor, the more likely he or she can get useful and reliable information that is not necessarily available to others in a timely fashion. For a detailed review of the sources and applications of social capital and its theoretical implications, please refer to Portes (1998).

In science and engineering, social capital is often closely related to human capital. Bozeman (2004) argues that these two are not easily disentangled in the practice of science and the career growth of scientists. His definition of science and technological human capital, in addition to explicit and tacit knowledge, includes social capital–based network ties. Scientists and engineers need both human capital and social capital in their work, and they will use both of them when needed, either when they work independently or collaboratively. Their field of research and education leads to certain network ties, and their human capital and what knowledge they can learn and create are influenced by their contacts and resources.

In the meantime, the social capital that scientists and engineers have may also influence their employment opportunities and incomes. This may be especially true when social capital and human capital is embedded in each other. The U.S.-educated may have more social capital in the U.S. context than their foreign-educated counterparts because of the connections they have established during their studies in the U.S. For instance, the U.S.-educated may have an advisor who knows an individual in an organization who knows about an opening in the organization that is not publicized. This candidate may have the access to this position before anyone else does. The network can also bring the candidate exclusive information about a well-paid job. Given the importance of all sorts of capital to one's career, the U.S.-educated may benefit more from this part of human capital than their foreign-educated counterparts. The human capital obtained in different regions is associated with the different levels of social capital, which eventually leads to differences in earnings.

The above studies argue that other things being equal, education obtained abroad is sometimes associated with lower earnings or lower achievement in other aspects of labor market outcomes. This is especially true if the degree is obtained in a less-developed and/or non-English-speaking country or region. One explanation is that the education systems in other countries and regions, especially if less-developed, are quite different from those in host countries, which are developed nations, such as the U.S. and Norway. As a result, the degree or education obtained in the former may be valued less than that obtained in the latter and lead to earning disadvantages. Also, degrees obtained in the U.S. may be accompanied with more social capital accumulated during the study in the U.S., which may lead to better employment opportunities that pay more. This discussion provides a useful framework of testing the influence of degree origin on the earnings of Asian computer scientists and engineers. However, while arguing that the region-specific human capital plays a role in determining earnings, these studies do not explain why this is so. More specifically, they do not examine the quality of education in general and in various aspects, such as English, mathematics, science, and engineering education. Another explanation may be cultural discrimination in that employers in the host country tend to value its domestic education more than education in other countries or regions, but the previous studies have not explored that possibility.

2.1.3 The Interplay of Structure and Human Capital and its Change over Time

While the structural perspectives examine the effects of structures on the status and behaviors of different groups, the human capital theory focuses on individual-level characteristics. Nevertheless, structure and human capital may not be mutually exclusive in explaining workers' earnings. In some cases (*e.g.*, a specific gender group, an employment sector, or a field), both structure and region-specific human capital may be at play. In addition, the interplay of the structure and region-specific human capital may change over time. At a certain time, human capital or education obtained in a foreign region might be regarded as of lower quality than that obtained in the U.S., and the foreign-educated may be oppressed in the form of being paid less. However, the highest degree from the same region obtained a decade later may be regarded as of similar value as that obtained in the U.S., and foreign-degreed workers are not paid less than their U.S.-educated counterparts.

Yet, the improvement in education in that world region alone can not lead to such a dramatic change. In the case of Asia, the world ranking of some higher education institutions has improved over time, but the number of institutions that are considered anywhere near the prestige of some Western institutions remain low. The other major contributing factor to the disappearance of earning disadvantage of foreign-educated workers is the changes in U.S. public policies. These policy changes may include the increase in the number of work visas awarded to foreign nationals, and more foreign nationals, especially foreign-educated, may have more or better opportunities to choose employers than they may if the visa policy is quite stringent. Thus, while workers trained in a region outside of the U.S. earned less due to their degree origin 10 years ago, the same group of workers (although not the same individuals) trained in the same region may not earn less than their U.S.-educated counterparts today due to the structural changes (change in the quality of higher education in Asia and immigration policy changes in the U.S.).

The change in the interplay of structure and human capital does not happen without globalization. Globalization has led to changes in public policy in various regions and nations, including those in educational systems. Dobbin, Simmons, and Garrett (2007) review the types of global diffusion of public policies. One type is social construction, which refers to the voluntary adoption in some countries of the policies that are proved to be successful in other countries. Clearly, in some world regions, such as Asia, many countries have introduced the Western education models to their higher education systems in an effort of improving the competitiveness of their degrees in the world, or in other worlds, closer to the quality of degrees in the West, notably the U.S. and some European countries. The structural change in higher education systems in Asia due to globalization can lead to a change in the real and/or perceived quality of human capital obtained in Asia. Furthermore, the increasing connections between Asia and the West due to globalization can lead to a larger global network, or better social capital, of Asian-educated workers. Then, the change in the quality of human capital obtained in Asia can lead to a change in the earnings of its recipients in U.S. work organizations.

In addition, the change in the earnings of the recipients of workers trained in a region outside the U.S. in U.S. work organizations is also interacted with the U.S.

national policy regarding immigration and labor shortage. When the supply does not meet the demand in certain fields, including science and engineering, policies would facilitate the coming of trained workers from the world. The favorite policies may eliminate the earning disadvantages associated with the foreign degree that they may otherwise encounter. My work precedes previous studies by examining the effects of the interplay of the two major influences, structure and human capital, as well as its change on earnings.

In sum, this section has briefly reviewed theories that can explain earning differences of workers with different demographic and educational backgrounds and studies testing these theories from societal and organizational structural perspectives as well as human capital theories. This section also proposes a synthesis of the theories and discusses the interaction of the structures and human capital. In the next section, I review literature uniquely on science and engineering. They include the career achievement of Asian scientists and engineers and race, gender, the intersection of race and gender, and immigrants in science and engineering.

2.2 Literature Review

The structural perspectives argue that women's and men's status and behavior in an organization is determined by the structures they encounter there and in the larger society. The literature of scientists and engineers has also revealed the barriers and disadvantages of women and minorities, including Asians, in S&E due to their structural positions in the broader society and in the workplace. This section reviews the literature that discusses the various aspects of the career attainment of women and minorities as well as immigrant scientists and engineers.

2.2.1 Asian Scientists and Engineers' Career Attainment

Making up about 4% of the US population, Asians are overrepresented in S&E fields in various employment sectors. In academia, of the 214,000 doctoral S&E faculty in universities and colleges in 2003, about 80% were white, 12% were Asian, 4% were black, 3% were Hispanic, and less than 1% was American Indian/Alaska Native (Burrelli 2006). In non-academic settings, for instance, the National Institute of Health (NIH), Asians make up 21.5% of all tenure-track investigators, which is equivalent to assistant professors in academia (Mervis 2005). Industry also has a large share of Asians, partly because they are overrepresented in engineering (NSB 2008).

However, it does not mean that they fare as well as whites in these settings. Asians suffer from "glass ceilings" in their careers, as revealed in earlier studies. These studies usually aggregate data and combines Asians of all citizenship status. In academia, Asian S&E faculty are not tenured at the same rate as their white, black, and Hispanic colleagues. In 1989, among doctoral academic scientists and engineers in the U.S., 56% of whites were tenured, but only 43% of Asians were. While 42% of these white doctoral scientists and engineers were full professors, only 35% of these Asians were. In addition, Asians were absent from leadership positions, such as deans, advisory board members, and institute heads (Miller 1992). Recent data show some narrowing of the gap. Burrelli (2006) reports that in 2003, among all faculty with S&E doctorates, the proportions of tenured professors were 52% for Asians, 63% for whites, 52 % for blacks, and 55% for Hispanics. The percentages of full professors were 35% for Asians, 46% for whites, 32% for blacks, and 37% for Hispanics. The percentages for blacks and Hispanics must be placed in the context of their overrepresentation in historically black colleges and universities and Hispanic-serving institutions. Nevertheless, Asians and other minority faculty in S&E fields did not fare as well as their white counterparts.

In national labs, Asians are overrepresented in investigator positions but underrepresented in leadership positions. At NIH, in 2005, Asians comprised 21.5% of tenure-track investigator, but they made up only 9.2% of tenured researchers. In its approximately 200 labs and branches, only about 4.7% of their chiefs were Asian. In the American Society for Biology and Molecular Biology, Asians are absent from the 11 standing committees (Mervis 2005). If an organization has a dual career ladder, *i.e.*, technical and managerial, Asians are often overrepresented in the former and underrepresented in the latter (Woo 2000).

Some scholars attribute Asians' low representation in managerial or administrative positions, in both the industrial and academic settings, to the lack of clear promotion process and evaluation standards. Oftentimes, Asian scientists and engineers are passed over for promotion (Wong and Nagasawa 1991; Miller 1992; Woo 1994; Woo 2000). Other reasons for the glass ceiling include the stereotypes that Asians are not good at interpersonal communications or speak English well and their lack of access to important structural resources. These resources include the "old boy's network," mentoring, especially by Asian managers as mentors, and management training or access to important developmental assignments which can lead to visibility in the organization (Miller 1992; Woo 2000).

Tang's (2000) study well exemplifies Asians' barriers in engineering. She examines the employment, career identity, and mobility of Asian engineers, both U.S.- and foreign-born, with at least a bachelor's degree, compared with white and black engineers. Her main data source is the Survey of Natural and Social Scientists and Engineers (SSE), compiled by the Bureau of the Census for the National Science Foundation. Data were initially collected in 1982, and follow-ups were conducted in 1984, 1986, and 1989. In the 1982 sample, 85.1%, 4.7%, and 10.1% of the engineers were white, black, and Asian, respectively. She used the 1982 data to test the employment status and the professional identity as an engineer or a manager. To test the movement between technical and managerial positions, she used the data of 1982, 1984, 1986, and 1989. In the descriptive chapter of employment trends, she also integrated data in the 1990s.

Tang finds that in engineering, Asians in general and foreign-born Asians in specific are more likely than their white counterparts to be unemployed. The odds of all Asians being unemployed is 1.56 times as high as those of their white counterparts. Furthermore, Asians are less likely and blacks are more likely than their white counterparts to be employed in academe. Yet, foreign-born Asians are not less likely than comparable whites to be employed in academe. The nonexistence of Asian-white gap in academic employment among immigrant engineers may be explained by Asian immigrant engineers' concentration in academic R&D, their "niche" fields, due to their preference and others' expectation on their technical excellence. In terms of professional commitment and identity, while Asians and blacks are more likely to do technical jobs, whites are more likely to take managerial tasks. While Asians (but not blacks) tend to self-identify as "engineers," whites are more likely to regard themselves as "managers."

In terms of achieving management or administration positions, compared with their white counterparts, both blacks and Asians have lower odds of being in general management (23% and 34% lower, respectively). The same pattern holds for both groups regardless of nativity. Asians also have lower odds of being in R&D management positions (31% lower), and more specifically, this pattern holds true for the foreign-born. Thus, both Asians and blacks are segregated in certain positions, but Asians are even more segregated in technical positions. In short, well-educated minority engineers have not transferred their skills to corresponding rewards.

In terms of earnings, an earlier study (Lee 1993) that uses census data, finds that Asian-born scientists (including social scientists) and engineers, either U.S.- or foreign-educated, do not earn lower wages than their native-born white or Asian counterparts. This result is obtained after controlling for education, experience, English skills, and labor market segments (monopoly, regional, or local). Lee explains that Asian-born scientists and engineers are integrated into the U.S. labor market. However, this study does not consider the origin of the human capital.

A more recent study, however, presents different findings regarding the earnings of Asian scientists and engineers. To overcome the fact that the studies of Asian scientists and engineers do not usually disaggregate data by ethnicity, Varma (2006) explores the career attainment of Asian Indian immigrant scientists and engineers. Her study includes a total of 120 interviewees, all of whom were immigrant scientists and engineers, had received a master's or a doctoral degree, and were not on temporary working visas (*i.e.*, H1-B). Among them, only 21 were female. Most respondents (95%) were between 20 and 60 years of age, and women on average were younger than men in the sample. Among the 120 interviewees, 82 were working in academic institutions, industrial companies, and government in the U.S., and 38 had returned to India after studying and/or working in the U.S. Varma reports that 57% believe and another 15% are not sure but guess that they are paid comparably to their colleagues. Nine percent believe that they are paid more than their peers because of their good reputation in the field due to their hard work. However, 15% believe that they are paid less but have never taken actions to get their salaries corrected, and the rest 4% have get their salaries corrected. Nevertheless, Asian Indian immigrant scientists and engineers believe and accept as a reality that they have to work harder and outperform their colleagues to be paid the same. Among these Indian scientists and engineers, gender differences also exist. In all the four settings (*i.e.*, industry, academia, and national lab in the U.S. and in India), and especially in academia, a higher proportion of females than males believes that they are paid less than their colleagues. In academia, 14% of males thought they were paid less than their colleagues, but 50% of women thought so. In all settings, no female reports being paid more than their peers.

Furthermore, Varma reports that a majority of these Asian Indian immigrant scientists and engineers find that they experience a “silicon ceiling.” In terms of promotion, 33% of all the respondents report that it took them same time as and 5% report less time to be promoted than their colleagues. Another 34% report more time they had to wait for promotion than their peers. The rest 28% of the respondents entered the current organizations too recent to be considered for promotion. For those who report same time, they believe that it is because their organizations use standardized promotion intervals. For those who report less time, they believe that their organizations reward employees fairly. Yet, in addition to their good performance, they have to work extra hard and prove their abilities twice as much as their peers to be rewarded. The major reason for the longer waiting period for promotion is that they have to prove themselves while it does not apply to their colleagues, especially non-Hispanic whites. Most respondents who report longer waiting time believe that the criteria for them are different from those for non-Hispanic white colleagues. In general, factors that disadvantage them for promotion, compared with their white colleagues, include their being less aggressive, knowing less about how the system works, and lack of mentoring. Here, the gender difference exists in promotion among the respondents. Across sectors in the U.S. and also for those who had returned to India, a higher percentage of females report longer waiting time for promotion than men. For instance, 54% of men and 75% of women in national labs and 24% of men and 50% of women who had returned to India reported longer waiting period than their colleagues. For these women, further barriers come from gender and gender-related issues, such as having a family. However, no field difference or degree variation is reported in this study.

2.2.2 Gender and Race in Science and Engineering

Compared with studies of Asian scientists and engineers, much more studies examine women scientists and engineers and, to a lesser degree, underrepresented racial/ethnic minorities (African Americans, Hispanics, and American Indians). Before discussing the literature on women and underrepresented minorities in science and engineering, I review studies that examine the structure of science. These studies explain what the structure is in science and how it works for or against certain groups.

2.2.2.1 Structure of Science: Scientific Norms

According to Merton (1978), science is different from other social institutions due to its unique scientific norms. One of the norms is universalism, which requires that scientists accept a scientific statement or claim based on merit and not functionally-irrelevant features, such as the author's race, class, religion, gender, and other personal features. Under universalism, science is open to all, irrespective of one's personal characteristics. More broadly, universalism represents how rewards should be distributed. Similarly, Blalock (1967) argues that certain fields, such as sports and science, have clear and objective evaluation criteria. As a result, these fields are more favorable to minorities in the sense that anyone achieving the highest standards should be rewarded over those not doing so. In baseball, for instance, the performance of players—batting averages, slugging averages, strikeouts, home runs, etc.—is objectively judged in a precisely quantitative way that can be standardized across teams and players. A player can be easily evaluated against competitors, regardless of his or her race/ethnicity. According to Blalock, science and academia share with baseball in objective evaluation. Scientists' and academics' performance is evaluated through publications and other research contributions but not in terms of personal characteristics. In science and academia, Jews are overrepresented based on their population ratio due to the fact that these fields feature objective evaluation.

Universalism should be understood in the context of the four ideal norms that Merton proposed in the context of Nazi Germany's attack on the autonomy of science. In Nazi Germany in the 1930s, the research of pure science was weakened due to the racialist purge and the utility orientation of the State. Some scientists in Germany at that time were expelled from science because of their race, and scientific research was driven by the economic interest of the State rather than scientists' pure scientific interests. The four norms that Merton proposed are institutional values internalized by scientists. He believes that science progresses best in democracy and when scientific norms are observed. In addition to universalism, other norms include communism, disinterestedness, and organized skepticism. Communism argues that scientific knowledge belongs to the community rather than the discoverer, and scientists should recognize the contribution of the authors of previous studies. Disinterestedness controls a wide range of motives that characterize scientists' behaviors because they are surveilled by fellow scientists. If a scientist has misconducts to achieve a certain goal, he or she will be caught by other scientists. Organized skepticism requires scientists not to blindly accept other scientists' findings until they are empirically and logically proved.

Studies have tested universalism in the reward system in science and find evidence both for and against it. Although Merton argues that universalism is an ideal, some authors have defended the existence of this norm in science. Gaston (1973) argues that in Britain, universalism works in the high energy physics (HEP) community. He finds that HEP scientists' productivity is not significantly influenced by their social class origins or the types of schools they attended for secondary, undergraduate, and doctoral education. Productivity is mainly predicted by professional age and the type of current university. Recognition is not explained by social class origins or the type of secondary school, undergraduate universities, or current affiliation. It is influenced by productivity and the type of work—the two major types of scientists working in HEP are theorists and experimentalists. Theorists are significantly younger than experimentalists, but they are generally more productive. Theorists also receive a larger amount of recognition for the same amount of publications than experimentalists due to their broader approach which can be recognized by more peers. In short, scientific productivity is predicted by professional age, and recognition is predicted by productivity and the type of work (theorists or experimentalists). Social origins do not play a role in the reward system, and HEP in Britain operates in a universalistic fashion.

Cole and Cole (1973) also argue that science, to a large extent, represents its ideal norm of universalism in that what determines the distribution of rewards in science is the quality of one's work evaluated by colleagues. The social origins of scientists, i.e., their doctoral origins, account for only a small part of the differences on scientists' rank, and thus the effect of "accumulative advantage" is minimized in science. Another work by Cole (1979) argues that science is fair in that women are not discriminated against. His analysis shows gender differences in many aspects, including ranks, visibility, reputation, and performance, notably the quantity (productivity) and quality (citation) of research. However, the first three inequalities disappear when the quantity and quality of research are controlled. Reskin (1980) criticizes Cole's work by pointing out that Cole treats performance as an exogenous variable and ignores the reciprocal relationship between productivity and position. She argues that research shows that institutional resources significantly influence scientists' productivity, and women are concentrated in lower-level positions that do not have access to these resources. In addition, the position has a stronger effect on productivity than the other way around, and women tend to be in lower positions. As a result, Cole's conclusion that science is fair to women is not solid.

More studies, however, assert that the ideal of universalism does not exist in science to the extent that it can or should. The following parts of this section review those studies. They find that functionally irrelevant features, such as one's race, nativity, and gender, influence how a scientist is treated, evaluated, and rewarded. Women and minorities are at a disadvantage at all stages, from participation to evaluation and rewards.

2.2.2.1 Participation

The numbers of S&E degrees awarded to women increased over time. At the bachelor's level, women have earned about half of S&E degrees since 2000 (NSB 2008). The Commission on Professionals in Science and Technology (CPST) (2004) reports that at the doctoral level, women continuously increased their number and share in receiving S&E doctorates in the past a few decades. They earned 924 S&E doctorates or 8% of all S&E doctorates in 1966 but 9,819 or 37.4% in 2004 (CPST 2006).[2] In 2005, women's share of S&E doctorates reached a record high of 46% (NSB 2008). However, their participation is concentrated in a few fields, such as biological sciences, psychology, and some social sciences, in which over half degrees at each level are awarded to women. Their representation in other fields, such as engineering, physical sciences, and mathematics and computer sciences, although increasing in the past decades, is still quite low, especially at the doctoral level. In 1985, women earned 9%, 17%, and 16% of all doctorates in engineering, mathematics and computer sciences, and physical sciences, respectively. Their shares in 2005 increased to 20%, 24%, and 29%, respectively (NSB 2008).

Women's shares in employment in these fields also significantly increased over time but unevenly across fields—at all degree levels, over half of social scientists and urban planners were women in 2002, and 41.6% of all biological and life scientists were women in 2002, up from 9% in 1983. However, from 1983 to 2002, women's representation rose by about 15% (from 23.5% in 1983 to 38.2% in 2002) in the natural science occupations but only by 4% (from 10% to 14%) in engineering occupations in the 20 years (CPST 2004).

Women's underrepresentation is especially obvious in the academic setting and has not changed much over time. Long and Fox (1995) report that women represented only 18% of doctoral science and engineering faculty in the U.S. in 1991. Committee on Science, Engineering, and Public Policy (COSEPUP) (2007) reports that women made up about 20% of doctoral science and engineering faculty in the early 2000s. In addition, compared with their progress in receiving S&E degrees, their workforce representation, especially in academia, is much smaller. Women are concentrated in non-tenure-track and junior positions but underrepresented in tenured faculty and full professors in S&E. An American Association of University Professors (AAUP) survey shows that among all respondents of all disciplines, 26% of the full professors, 40% of the associate professors, and 48% of the assistant professors are women. For comparison, a survey by the American Chemical Society (ACS) shows that among faculty who were ACS members, the percentages for women are 16%, 27%, and 29% at the full, associate, and assistant professor levels, respectively (Heylin 2008)—much smaller than women's representation of all disciplines at each rank level. In the 50 most research-intensive chemistry departments in the U.S., measured by the amount of total and federal funding spent on chemistry research in 2005, the percentage of women faculty rose from 10% in 2000 to 15% in 2007. The proportion of women at the assistant and full professor levels increased by 4% and 5% (from 18% to 22% and from 6% and 11%, respectively), but their share at the associate professor level increased by only 1% (from 21% to 22%). In the 51st to the 100th institutions, the proportions of assistant and full professors in 2007 were similar to those in the top 50 institutions, but the share of associate professors in the 51-100 institutions was lower at 18% (Raber 2007).

Similarly, in academic geosciences, women's share is less than 20% for all ranks and decreases with increasing rank, and many women work part time or in other non-tenure track positions. Furthermore, in 2003, over 60 Ph.D.-granting geosciences departments in the U.S. did not have women faculty, and over half of the rest had only one (Clark 2005). In mathematics, women represent about 29% of doctoral assistant professors but only 11.8% of associate and full professors with doctorates (Frehill and Di Fabio 2007). Even in social, behavioral, and life sciences, in which women improved their representation among degree recipients at each level in the past 30 years, in top research institutions, they made up only 15.4% of the full professors in the social and behavioral sciences and 14.8% in the life sciences (COSEPUP 2007). Apparently, women in science face various challenges, including competition between family and career, lack of female role models, isolation and lack of adequate mentoring, and difficulties in gaining credibility or respectability from peers and administrators (Rosser 2004; Lozier 2005).

Etzkowitz et al. (1994) analyze the barriers to the participation of women in academic science and engineering. They conducted 47 interviews with female Ph.D. students and female and male faculty members in four academic departments, physics, chemistry, electrical engineering, and computer science, as well as administrators in engineering and graduate schools in a Research I university. They find that several mechanisms serve as barriers to women's participation. The structure of the academic system, including the advisory system, can work against women. While some male advisors are supportive to female students, others are not. In fact, the negative experiences of some women with their male advisors lead them to doubt their self-worth, for instance, whether they are in the department because of their abilities or their gender (women as tokens). Furthermore, the type of socialization that women are more comfortable with, supporting interactions with teachers and other students, is not encouraged and treated as a symbol of inability in science. Also, women's comments and contributions are devalued or ignored in their group meetings and outside their departments, such as in professional conferences. The lack of supporting environment and the feeling of marginalization lead to women's low confidence, which may then lead to attrition. In addition, marriage and family have conflicts with work. This is true in many occupations but especially true in academic science, which requires exclusive attention to research in the years suitable for getting married and being pregnant. In graduate school, women are not treated seriously if they do not remain single. They are discouraged or even penalized to have children—some professors never accept women with children as students. Barriers for women also exist at the time of employment—departments often consider women's family obligations but not men's. Women faculty on the tenure track face a dilemma between pursuing tenure without worrying about other obligations and having children with the larger possibility of being denied tenure. Other barriers include the facts that married women have less geographical mobility than men because they tend to follow their husbands. If both are scientists, they are not likely to be hired in the same department, and women tend to find employment in a circumscribed region, usually in a less prestigious institution. In another study, Etzkowitz, Kemelgor, and Uzzi (2000) report that social and cultural barriers, such as different socialization, the feeling of being marginalized and isolated, and a lack of support system, work against women from childhood to the later phases of their careers in pursuing science and being fairly treated in science. A more recent study by Wentling and Camacho (2008) confirms their findings. In addition, Wentling and Camacho report social factors that influence women students' decision about pursuing an engineering degree. They include the male-dominated nature of engineering, the public image of engineers as mostly male, lack of women engineer mentors or role models, low expectations of women, and traditional views that do not approve engineering as appropriate for women.

Similarly, NRC (2006) analyzes challenges in recruiting women students and faculty in S&E and finds that challenges in recruiting women in S&E include both individual- and institutional-level factors. Prior to college, women are less likely to take high-level mathematics and have less positive views towards successful science and mathematics studies in college than men. At the graduate level, the department culture, or the dominance of male faculty and students, may unintentionally signal to women that they are not welcome and place them in a marginalized position. Women graduate students also feel a lack of family-friendly policy, and they have negative perceptions of graduate education and academic careers due to the small number of women in S&E. Their inadequate mentoring and negative experience in graduate school prevent them from taking postdoc positions and pursue an academic career. At the faculty level, challenges in recruiting women scientists and engineers lie in the departmental or institutional culture that does not favor women (such as male resistance to them) and a lack of action to support the participation of women. Also, women are less likely to be employed as S&E faculty because the search committees do not do a thorough search that increases the pool of women and minority applicants—a thorough search is more difficult and time-consuming than old hiring practices.

Women's difficulties in employment are also reported in other studies. Xie and Shauman (2003), using multiple data sources, find that after age, race, education, field, and sector are controlled, married women scientists without and with children have lower odds of employment than their male counterparts (56% and 41% as high odds as those of their male counterparts, respectively). CPST (2004) finds that women scientists and engineers are more likely than men to take part-time positions. They also tend to have higher unemployment rates than their male colleagues.

Change can occur if the university or decision makers take actions. The Massachusetts Institute of Technology (MIT) report (1999) on women faculty in its School of Science reveals how the actions that the administration took could lead to an increase in the share of women faculty in science. The Committee on Women Faculty in the School of Science, composed of a single tenured woman from each of the six departments in Science and three senior male faculty, who were or had been department heads, collected data in the six departments and conducted in-depth interviews with women faculty and department heads in the School. They find that women's representation in the School of Science has not improved much in years—it was 7.5% in 1985 and 8% in 1994. While the student body has been increasingly diverse, the faculty remains predominantly white and male. The administration took actions immediately after the report. In 1999, women made up over 10%, the first time ever in the history.

For underrepresented racial/ethnic minorities, notably blacks, Hispanics, and American Indians, their participation in S&E has increased over time, but they remain underrepresented, especially in S&E fields other than psychology, social sciences, and biological sciences (NSB 2008). In 2003, among employed scientists (including behavioral and social scientists) of all degree levels, 74.4% were whites, 17.9% were Asians, 4.8% were blacks, 4% were Hispanics, and 0.4% were American Indians/Alaska Natives. At the doctoral level, 17.8% were Asians, 3.5% were blacks, 3% were Hispanics, and 0.6% were American Indians. Among employed engineers of all degree levels, 77% were whites, 12.5% were Asians, 3.4% were blacks, 5.1% were Hispanics, and 0.3% were American Indians/Alaska Natives. Among employed doctoral engineers, 31.5% were Asians, 2% were blacks, 2.8% were Hispanics, and 0.4% were American Indians (NSF 2006: Table H-6 and Figure H-1). Clearly, the shares of black and Hispanic scientists and engineers were much lower than their population ratio, and their shares at the doctoral level were much smaller than their representation at all degree levels.

For black scientists, before major civil rights movements, employment opportunities outside Historically Black Colleges and Universities (HBCUs) were very limited. Over time, opportunity structures in employment have improved, and significantly more black scientists who received their doctorates after 1965 than those who did before 1955 received first jobs in industry. Yet, black scientists are still heavily concentrated in academia and government. Compared with their white counterparts, black scientists are more likely to start their careers in unranked and small departments with heavy teaching loads and limited research time and less likely to obtain initial appointments in distinguished departments (Pearson 1985). In mathematics, underrepresented minorities account for only 6.2% of all doctoral-degreed faculty at all ranks (data are aggregated to protect the confidentiality of the small number of respondents) (Frehill and Di Fabio 2007). In biological and agricultural sciences, underrepresented minorities make up about 6.5% of all faculty with doctorates (Frehill 2007).

2.2.2.2 Experience

As discussed earlier, the low representation of women and racial/ethnic minority in S&E is closely related to their negative experiences in S&E. The MIT report (1999), besides revealing the small number of women faculty in the School of Science, also reports the feeling of marginalization that women faculty experience. These women scientists feel that they are excluded from a significant role in their department, and the more senior women faculty experience a higher level of marginalization. The follow-up MIT report (2002) reveals that the feeling of marginalization, accompanied by inequities, is consistently found among women faculty in other Schools, as well, including the Schools of Engineering and Social Sciences.

Based on a survey of 409 female and 304 male engineering students in four large, first-tier, West Coast research universities, Vogt, Hocevar, and Hagedorn (2007) find that females of various ethnicities, including non-Hispanic Whites, Chinese, Koreans, Vietnamese, Japanese, Mexicans, Filipinos, South and Central Americans, South Asians, and African Americans, report being disadvantaged relative to their male peers and feel that they do not receive respect from their male peers as equals in engineering. However, their study does not analyze ethnic differences. In addition, both women and racial/ethnic minority graduate students report receiving increasing but still less mentoring and help from faculty than white students. One reason for their lack of mentoring is the shortage of women and racial/ethnic minority faculty who can serve as their mentors in these fields (Fox 2001; Nettles and Millett 2006).

For women undergraduate students, the type of institution plays a role. Those in women's colleges report more positive experiences than those in coed institutions. Women's colleges provide a more nurturing and a cooperative rather than a competitive environment, and the department culture is inclusive of all students and potential physics majors (Whitten et al. 2007). For minority students, the type of institution also plays a role. Brown, Morning, and Watkins (2005) find that African American undergraduate engineering students in HBCUs have the most positive and favorable perceptions of their college experience due to the friendly environment, and they have substantially higher GPAs than their counterparts in other types of institutions. However, the graduation ratio in HBCUs is not higher than that in other institutions due to the lack of financial aid available to HBCU students. Other studies show that factors that can improve African American, Latino, and American Indian students' graduation rate in science include financial aid, the existence of an academic community, and positive relationships with professors (Johnson 2007a).

For black physical, biological, and social scientists, Pearson (1985) reports that they feel somewhat excluded from the scientific communication network due to their concentration in HBCUs and white scientists' lack of confidence in black scientists. HBCUs often emphasize teaching over research due to limited financial support, and black scientists are regarded as lack of competence. The racially segregated employment contributed to blacks, especially those employed in HBCUs, communicating more with blacks rather than with scientists of all color.

2.2.2.3 Performance

In terms of role performance, Cole and Zuckerman (1984) find that women publish less than their male counterparts, but they are unable to explain the productivity puzzle. Xie and Shauman (1998), using multiple data sources, continue this task and find that first of all, the gap narrowed over time—women published around 60% as much as their male counterparts in the late 1960s but 75% to 80% as much in the late 1980s and the early 1990s. Second, women scientists' disadvantage in publication productivity may be explained by personal and institutional characteristics that tend not to benefit women's productivity. At the personal level, women are less likely to be married and have longer time from the bachelor's degree to Ph.D. At the institutional level, a larger proportion of women scientists works in teaching colleges and has heavier teaching loads than male scientists. They are less likely to work in research universities and have less research funding. The different academic structures with different access to valuable resources, including funds and research assistants, lead to the different research productivity (Xie and Shauman 1998). The influence of the institutional structures on performance is also reported elsewhere. Fox and Mohapatra (2007) find that the creative department climate, referring to an exciting, unconventional, creative, and warm climate, has a positive effect on the publication productivity of academic scientists in doctoral-granting departments. COSEPUP (2007) finds that the factor that critically influences publication productivity is the access to institutional resources. Other factors, such as marriage, having children, and taking care of the elder, have minimal effects.

Another study shows that not only direct measures, such as factors that Xie and Shauman (1998) and other scholars consider, but also indirect factors, such as specialization can explain the gender disparities in productivity. Leahey (2006), using the CVs of tenured and tenure-track sociologist and linguist faculty members at Research I universities, finds that men publish more and specialize more than women, with relevant variables controlled. The score of specialization is 1-(the number of topics published/the number of publications). In other words, the more publications on a certain topic, the more specialized one is. That men publish more than women can be explained by the facts that specialization is positively related to productivity and that women are less specialized than their male counterparts. Men are more specialized possibly because they have more collaborative opportunities with other scholars who have overlapping research interests, reinforcing their specialty in one or a small number of areas. On the other hand, women’s smaller network may require them to work in other research areas, leading to their more diversified research outcomes.

In another paper, Leahey, Crockett, and Hunter (2008) report that specialization significantly and positively influences publication productivity and its rate of growth among sociologists and linguists. Specialization has a statistically significant, positive effect on productivity but a negative effect on visibility or citation. Gender differences exist in that specialization has a statistically significant effect on the productivity of women but not men and has a statistically significant effect on the growth rate of productivity among men but not women. Men’s productivity begins to exceed that of women in six to seven years and continues so, leading to large productivity gaps by mid career. Gender differences also exist in visibility in that, unexpectedly, specialization is more detrimental to men than to women, but it does not influence the growth rate of visibility for either men or women. Furthermore, men earn more visibility than women based on the same productivity. This gap may be explained by the fact that men are more likely to publish in top journals and men have large networks of mutually-citing collaboration.

For black scientists, they do not differ much in performance from their white counterparts. If they do, it is more likely due to external factors. Pearson (1985), using survey data of 565 black and 722 white scientists, finds that whites publish more career articles (28 for whites and 15 for blacks), are more likely to co-author works, and present more papers at professional conferences, but blacks publish slightly more books, including textbooks, and receive slightly more grants. More disaggregated data of productivity for minority scientists by field are not available due to the small number of observations. Based on interview data, Pearson (2005) reports that the difference in research-related activities is determined by the institutional affiliation. Black chemists consistently report that their employment in HBCUs often leads to less favorable grant reviews due to the subjective peer review system.

2.2.2.4 Rewards and Advancement

For scientists of different gender and race/ethnicity, the same level of performance does not necessarily lead to the same type of rewards. The MIT report (1999) find that although women faculty in science have achieved professional accomplishments equal to those of their male colleagues, they receive less in space, awards, resources, and response to outside offers than men.

As discussed earlier, women are underrepresented in tenured and full professor positions but overrepresented in untenured and junior faculty positions. Even after controlling for publication productivity and institutional affiliation, women's estimated ranks are still lower than those of comparable men in physical sciences, mathematics, and engineering (Sonnert 1995). Women faculty in S&E are also promoted more slowly and receive fewer honors and leadership positions (COSEPUP 2007).

McIlwee and Robinson (1992) find that in engineering firms, women are less likely than men to be in high-status positions, such as R&D engineers, but more likely to be in lower-status positions, such as production and sales engineers, although they share the title “engineer.” Women engineers often do well in the first a few years of their careers, but they are less likely to advance into high-status technical or managerial positions. They argue that women’s disadvantage in advancement in engineering firms can be attributed, first, mainly to the structure; second, to a lesser degree, to the different gender roles that men and women have; and third, the interaction of the structure and gender roles. According to McIlwee and Robinson, the structure of the workplace in engineering defines power relations, and the power relations shape the culture of the workplace. Gender roles and the backgrounds and interests of male engineers who are more powerful than women engineers and have an interest in maintaining their power shape the culture and determine the content of the culture. The culture of engineering is masculine, focusing on technical competencies and aggressiveness, which are more pertinent to male’s gender role than to women’s. Once the culture of engineering is formed, it becomes a reality and influences the interactions of male and female workers in this culture.

Xie and Shauman (2003) find that among all women scientists, net of other factors, only married women with children have significantly lower odds of promotion—they have only 24% as high odds of promotion as their male counterparts. The negative influence of having children is also reflected in geographic mobility. Women scientists with children are less mobile than men, and this gender gap is the largest for those with children who are 7-12 years old—women scientists have 43% less odds of mobility than their male counterparts. In addition, among employed scientists with children, women scientists work fewer hours per week than male scientists, although the difference decreases with children's age. The spouses of female scientists work longer hours than those of female scientists. Other studies find that women scientists are more likely than their male counterparts to be not married, have no children, or delay having children in order not to be negatively influenced by obligations associated with marriage and motherhood (Xie and Shauman 1998; Grant, Kennelly, and Ward 2000; Fox 2005). Another way to deal with work-life balance is to choose a non-tenure track position, and many women engineering faculty deliberately choose such a position. A statistically significantly higher proportion of non-tenure-track women engineering faculty report positive than their tenured or tenure-track counterparts (68% vs. 57%) (Birmingham and Wasburn 2008).

In industry, women scientists do not fare much better than those in academia, when compared with their male peers. A report from the Anita Borg Institute for Women and Technology (Simard et al. 2008) shows that men are 2.7 times as likely as women to be in high-level positions. At the mid-level, the most critical stage for women on the technical career path, women, primarily white and Asian in their study, face various barriers to advancement. In the workplace, mid-level women are believed to be less technically competent than their male counterparts. They are more likely than men to believe in extended work days as well as connections to power and influence as requirements for success. Similar to mid-level men, they perceive that cooperation is essential to success in technology, yet they feel that when it comes to promotion, what is rewarded is competition rather than collaboration. In terms of work-family balance, both mid-level men and women perceive that the focus on family leads to a penalty to success, but women are more likely to suffer from poor health due to work demands. Compared with mid-level men, mid-level women are twice as likely to delay having children. Fassinger et al. (2007) report that women in chemical firms feel that they are often passed over for advancement opportunities. Nevertheless, their managers, especially male managers, think that women receive sufficient support from the firm and their supervisors.

Yet, although women still do not fare as well as their male counterparts, industry provides better rewarding opportunities to women than educational institutions and government. Smith-Doerr (2004) finds that although women life scientists are less likely than their male counterparts to receive early supervisor positions in all employment sectors, namely, industry, universities, and government, women in biotech firms are more likely than women in the other two settings to be supervisors. This fact is due to the higher levels of flexibility and opportunities that women receive in biotech firms than those in government or educational institutions. The flexibility in industry is attributed to its flat structure, transparency, flexible collaborative choices, and collective rewards.

The difference in rewards to men and women may be due to implicit bias. Both the MIT report (1999) and COSEPUP (2007) find that gender discrimination is implicit and unconscious, which has been socialized into both men and women, although not necessarily the same way. Long and Fox (1995) argue that the less information is known about candidates and the less transparent the criteria of selection, the more likely the allocators' discretion affects their decisions. Over time, women accumulate disadvantages in receiving resources and higher ranks that can significantly influence their performance, which further places them at a disadvantage in receiving resources.

For doctoral black scientists, irrespective of the year of receiving degrees, they report that their racial status limits their career mobility. But a smaller proportion of scientists of younger cohorts than that of earlier cohorts believe so. Specifically, black scientists report experiencing difficulties in receiving research funds, and they lack facilities and time for research (Pearson 1985). Black chemists cite the institutional and attitudinal bias, such as advisors' lack of confidence in their competency, as barriers to professional achievement. Furthermore, their current affiliation can impair their grant-seeking efforts, since proportionately more blacks are employed in less-research-intensive and unranked institutions (Pearson 2005).

2.2.2.5 Earnings

An important part of rewards that is more pertinent to this study is earnings. In terms of earnings, women scientists and engineers are paid less in both academia and industry. In a survey conducted by the American Association of University Professors, in 2007–08, women faculty in all fields and at all ranks at bachelor's- and master's-granting schools earned salaries that were very close to those men. At Ph.D.-granting schools, the gender gap was larger in that averagely, women earned 91% or 92% as much as men. In the American Chemistry Society survey sent to its members, among full professors at Ph.D.-granting universities in the U.S., women earned $101,500 while men earned $111,400 (Heylin 2008).

Studies that control for relevant variables lead to similar findings. The MIT report (2002) reveals that women faculty earn less in the Schools of Science and Engineering. In 1989, among full-time scientists and engineers, after controlling for various variables, such as age, race, education, field, employment sector, and weeks and hours worked, unmarried women, married women, and married women with children earned 7%, 14%, and 14% less, respectively, than their male counterparts (Xie and Shauman 2003). An NSF study (Lal, Yoon, and Carlson 1999) shows that in 1995, women engineers in all employment sectors were younger and earned 13% less than male engineers. Ten percent of the salary difference could be explained by work experience (years since receiving the bachelor's degrees). Yet, when other factors, *i.e.*, the field of education (engineering vs. non-engineering), the level of the highest degree, the employment sector, the geographic region, and engineering specialty are controlled for, women still earned 2% less than men.

The above findings are consistent with those of Long's (2001) study of scientists and engineers from 1973 to 1995 and the more recent study by COSEPUP (2007). Long (2001) finds that as a group, women were younger, had shorter professional age, and earned about 20% less than their male peers. After 20 years of work experience, male scientists and engineers' salaries continued to rise, while those of women did not. When factors such as work experience and field are held constant, women scientists and engineers still earned 6% less than their male peers in 1995. Nevertheless, this gender difference in pay decreased over time. Long also finds field differences in that the gender gap in salaries was larger in some fields such as engineering and mathematics than others such as life, social, and behavioral sciences. More recent reports still find that women academic scientists and engineers earn less than their male colleagues (COSEPUP 2007).

Studies of cohorts reveal that the earning disadvantage of women engineers, compared with their male counterparts, is due to cohort effect but not the glass ceiling effect. Morgan (1998) uses data from the Survey of Natural and Social Scientists and Engineers (1982, 1984, 1986, and 1989) as well as the 1992 Survey of Men and Women Engineers to examine both the cohort and glass ceiling effects. The glass ceiling effect refers to net of other factors, the gender difference in earnings within cohorts will grow over time because of the disadvantages that women accumulate over time. The cohort effect argues that net of other factors, the earning difference between women and men are greater in older cohorts because the labor market becomes more equal over time and favorable to younger cohorts. Using Tobit regression, she finds that after human capital, family, race, work setting, and region characteristics are controlled for, of the three cohorts, in each of the four years of available data (1982, 1984, 1986, and 1989), only the oldest cohort (receiving their degrees in 1971 or earlier) of women engineers earned significantly less than their male counterparts in the same cohort. The middle cohort (1972-1976) of women earned less in 1982 but not other years. And the youngest cohort (1977-1981) of women did not earn significantly less than their male counterparts in any year. The 1992 data do not reveal any female disadvantage. In addition, the female disadvantage in any year was fairly consistent. Thus, Morgan concludes that the female earning disadvantage is due to the cohort effect, that older cohorts of women tend to earn less than comparable men but the younger cohorts do not.

However, this study is criticized by Alessio and Andrzejewski (2000) in that Morgan does not consider the gender gap in response rates over years and the top-coding (treating salaries over a certain amount as the same as the amount) of respondents' incomes may influence the findings. The fact that response rates between men and women widened over years could indicate a hidden glass ceiling—women were less likely to survive than men over years. Furthermore, the incomes of 1.7% of male respondents but only of 0.2% of female respondents were top coded, which could mask the male advantage to a certain degree.

Another study that examines the earnings of women scientists and engineers reveal neither cohort nor glass ceiling glass effect but consistent female earning disadvantages across field. Prokos and Padavic (2005) test the cohort effect and glass ceiling effect hypotheses. Based on the results from the 1993, 1995, 1997, and 1999 SESTAT data, they find that in 1993, 1995, 1997, and 1999, neither of the six cohorts (1955-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, and 1985-1989) experienced significant changes over time in terms of the earning gap with comparable males. Thus, the glass ceiling effect hypothesis is not supported. Furthermore, the older cohorts did not always experience a larger gender gap in earnings than the younger cohorts in all the four years. Thus, the cohort effect hypothesis is not supported, either. Yet, women earn less than their male counterparts, and these results were consistently found among engineers, physical scientists, life scientists, and computer and math scientists. The failure to find the glass ceiling effect may be attributed to unmeasured factors, such as women and men in the same job are paid differently or are segregated into different job levels although sharing the title. The pay gap could also be due to the organizational structures and practices that work for men but against women, which have been reported in various studies. The failure to find the cohort effect may be due to the fact that earliest cohorts of women scientists and engineers are more selected than the younger cohorts since the a larger number of the latter than the former had access to S&E occupations. In addition, greater employment and other opportunities for women are not necessarily the most recent.

For racial/ethnic minority scientists, same credentials do not lead to same pay. NSB (2008) reports that compared with whites and Asians or Pacific Islanders, underrepresented minorities (*i.e.*, blacks, Hispanics, and American Indians) with S&E degrees experience statistically significant salary disadvantages at each degree level, even after controlling for age, years since degree, field of degree, occupation and employer characteristics, and family and personal traits.

In sum, women and minority scientists and engineers face structural barriers in various aspects of their careers. They were historically at the “outer circle” of science and have not significantly progressed in science and engineering. Historically, women were somewhat excluded from science. When they had access to science, they face various barriers and disadvantages. For instance, they move much more slowly in the academic hierarchy, they work as research associates rather than as regular faculty, and they have less collaboration and run fewer big laboratories (Zuckerman, Cole, and Bruer 1992). Even today, women’s as well as racial/ethnic minorities’ training has not benefited them in terms of participation, career status, advancement, and earnings to the same extent as their white male peers.

2.2.3 Minority Women in Science and Engineering

While most studies of scientists and engineers examine women and some study racial/ethnic minorities, fewer investigate minority women (*e.g.,* Pearson, 1985). However, as Harding (1990) argues, there is no typical woman. Women differ in experiences and perspectives due to their race, nationality, culture, class, etc. Women in science with different backgrounds have different experiences, and the results based on aggregate data do not provide insights regarding the status of women in minority status. Leggon (2006) argues that the analyses of women scientists based on aggregate data by race or gender obscure racial differences among scientists of the same gender and gender differences among scientists of the same race/ethnicity. More broadly, the examination of the intersection of race and gender applies to studies in not only S&E occupations but also others in order to understand the inequality of labor market outcomes (Browne and Misra 2003; Leicht 2008). Thus, to better understand the status of women scientists and engineers, studies should examine women of different demographic backgrounds rather than treating them as a homogenous group. In general, minority women tend to be more disadvantaged than white women or minority men.

2.2.3.1 Barriers

One factor that affects minority women's underrepresentation in S&E majors and occupations is that they face more barriers to their S&E careers. Hanson (2004), using data from the National Educational Longitudinal Study (1987-88, with follow-ups in 1990, 1992, 1994, and 2000), examines the loss of minority women in science due to various barriers. The sample includes 581 young African American women and 3,365 young white women (who were in 8th grade in 1988). She finds that African American women are a large science talent pool because they are more independent, and have greater self-confidence, higher educational and occupational aspirations than other women. From the second year in high school to their early adult years, young African American women have more positive attitude about science than their white counterparts.

They also have considerable access in terms of taking advanced science courses in eighth grade and after high school. However, young African American women's interest decreases over time, which may be attributed to institutional barriers, such as teachers' low expectation on their performance, the lack of minority women as teachers and mentors, and the invisibility of African American women scientists to children. The loss of talent during this process is associated with the unfriendly environment in educational and occupational institutions, which have not tapped and retained all science talent.

Furthermore, the way science is taught and the way science professors treat minority women students discourage these women. Johnson (2007b) interviewed and analyzed the experience of 16 minority women students in a large, predominantly white research university in the west of the U.S. All of them, when interviewed, were junior and senior students in an enrichment program for high-achieving minority students in the sciences and were still taking sciences classes other than physics (the author was a physics instructor). Among them, six are black women, seven are Latinas, and three are American Indian women. These students report several factors as discouraging them from getting involved in science, including large lecture classes, which prevent students from having direct, face-to-face interactions with professors. Furthermore, science professors often deal with questions in class, which is against the way women are socialized—they are socialized not to draw attention to themselves in public, especially when they think that they may be the only one to feel confused. In addition, undergraduate students are sometimes engaged in scientific research, and they want to find a mentor, yet, professors are impatient and too busy to give them friendly suggestions. They assume that researchers do not like them, partly because of their ethnicities. For these students, both their gender and race/ethnicity become barriers to their access to science.

In choosing an S&E major and career, minority women have different backgrounds and experience from men of the same race/ethnicity and women of other races/ethnicities. Based on in-depth interviews to 12 Hispanic women and 10 Hispanic male college students majoring in science and engineering, Brown (2008) examines gender differences among Hispanic students majoring in S&E. She finds that these Hispanic women have to fight with traditional female roles, such as being a mother and not working outside home. Even with their success so far being in college and with their study in S&E, the women still feel somewhat uncomfortable with the fact that they are S&E majors. In the male-dominated fields, they doubt whether they can successfully finish their studies and whether they are in the right field. In addition to their gender identity, they also have to deal with racial/ethnic stereotypes. Their Hispanic peers are not known as being intelligent or hard-working, and they have to deny their ethnic identity, which makes them distant from their friends of the same ethnicity. However, this is not a problem for most of the interviewed Hispanic male students.

Ryabov and Witherspoon (2008) report that Hispanic women faculty in S&E travel different paths from other women to their careers. Their study is based on interviews of 57 women faculty in 18 departments in natural sciences, social sciences, and engineering in a Hispanic-serving institution, which is also an NSF ADVANCE institution. Among the 55 interviewees who were taped (two interviewees requested not to be taped), 27 are U.S.-born, non-Hispanic white women, 18 are foreign-born women, and 10 are U.S.-born Hispanic women. The authors find that unlike the other two women's groups, Hispanic women did not have early expectations and were not socialized to grow up to be a scientist or engineer. Most of the Hispanic women grew up in families that had little or no education at the postsecondary level and in small, closely-knit communities that had no four-year colleges. However, their study does not disaggregate analysis by field, and thus, we do not know the field variation in these women faculty's experience. In both Brown's (2008) and Ryabov and Witherspoon's (2008) studies, interviewees mention the significant individuals who shaped their journal to where they are. They include their teachers and parents as mentors and support from their spouses, friends, and academic peers.

Studies have examined the lower probabilities of certain minority women in S&E occupations. Gatchair (2007), in her dissertation, examines the differences in the probabilities of being employed in S&E jobs among Asian, white, black, and Latino women. She finds that compared with their white counterparts, college-educated black and Latino women have significantly lower probabilities of S&E employment. College-educated Asian women have a higher probability of being employed in S&E jobs than comparable white, black, and Latino women. Gatchair argues that Asian women's advantages in S&E employment over other women can be attributed to a higher percentage of Asian women than other women studying S&E in college. Furthermore, employers' statistical discrimination which depicts Asian women as being competent in and familiar with technical issues works in favor of them. In addition, Asian women may have more extensive networks that provide employment information. Gatchair's study provides comparative knowledge on minority women's probabilities in S&E employment.

However, due to data limitation, she does not examine their earnings and the gender differences of the earnings of minority groups in S&E occupations.

2.2.3.2 Double Bind

After starting their careers as scientists and engineers, minority women feel the effect of the "double bind"—being both a minority and a woman in white- and male-dominated fields. Malcom, Hall, and Brown (1976) summarize an American Association for the Advancement of Science (AAAS) workshop that addressed the experience of minority women in science, engineering, and medicine. They find that the price of the "double bind" in science is very high because of their "differentness." Clearly, the academia and science were developed based on white-men lifestyles, which required the scientist to devote all his time to work and the wife to take care of the family. Thus, minority women scientists and engineers have to adjust their life and work styles by devoting more time, energy, and persistence into their work in order to catch up and succeed. At college and in graduate schools, having overcome academic pressures due to their inadequate academic preparation, minority women find themselves in a less friendly and supportive environment and that their lifestyles become further different from those of their minority women peers. Lack of role models and female peers lead to the feelings of isolation and loneliness, which are often accompanied by pressures to get married, choose more culturally acceptable occupations, and return to communities where they grew up. At work, both in industry and in academia, although less obvious in the latter, they experience discrimination in job assignments, salaries, and promotion. Extra burdens come from family and non-professional commitments, such as serving on various committees due to "tokenism." Furthermore, they need to keep "proving" their abilities to be accepted. In sum, these tenacious minority women have to overcome barriers because of their race, gender, and culture. The experiences of these scientists also point out the importance of considering the specific needs and concerns of minority women, who share some problems with white women but also have different needs and concerns from them (Malcom et al. 1976).

Since then, minority women have increased the numbers of S&E degrees that they earned and their shares among their racial/ethnic groups at each degree level. From 1990 to 1998 (or 1999 for doctorates), for instance, African American and American Indian women earned more S&E degrees (of all levels) than their male counterparts. Yet, in 1999, fewer women than men in all racial/ethnic groups worked as scientists or engineers (NSF 2003). In addition, minority women's experience in S&E in the late 1990s and the 2000s was not much better than those in 1976. Minority women still do not receive adequate support, even from senior women researchers. They still have to "prove" their abilities before being accepted and recognized, and they are still excluded from the "old boys' network" (Whitaker 2001). In addition, extra responsibilities due to their being both minority and women as well as the feeling of isolation due to the small number of women of color in computing are still prominent (Taylor 2002). Furthermore, Mahtani (2004) finds similar results based on interviews through email to 12 women of color faculty and graduate students in geography in the U.S., Canada, and Britain. She reports that these women feel that they are unwelcome, and their colleagues often question their abilities. They feel isolated, unappreciated, and discriminated against due to racism and sexism. What is more discouraging is that the institutional environment is not conducive to the participation of more women of color. No institutional efforts have been made to improve the representation of minority women in geography.

Pearson (1985) finds that compared with white men and women and black men, doctoral black women scientists published less articles and were least cited. Although they are less likely than black men to receive a grant, they are more likely than white men or women to receive at least a grant. Yet, about half of the black women respondents feel that their race and gender have somewhat limited their career mobility. Concentrated in historically black colleges and universities, they have very limited resources for research. Sexism places them to a more disadvantaged position than their black male peers. Pearson (2005) finds that black female doctoral chemists have to fight discrimination due to both racism and sexism in various settings. Black women chemists feel that they are not taken seriously by their peers, especially white males but also black males. Data on promotion or tenure for minority women are not available.

2.2.3.3 Earnings

In addition, minority women earn lower salaries than their male counterparts. Pearson (1985) finds that minority women scientists report the lowest earnings among black and white male and female scientists. In 1995, most of the salary differences are attributed to field and age variations (NSF 1999). More recent data (NSF 2000; NSF 2003) still show the gender difference in salaries. Yet, because of the small number of minority women, it is impossible to determine how much the salary difference could be explained by the highest degree. More recent NSB publications do not disaggregate earnings data by both race and gender, but NSF (2008: Table H-17) data show that in 2006, the median earnings of white, Asian, black, Hispanic, and American Indian women were $65,000; $68,000; $63,000; $55,000; and $60,000, respectively. Their earning disadvantages relative to men of the same racial/ethnic group were $15,000; $12,000; $7,000; $15,000; $1,000, respectively. In addition, most minority women's groups earn less due to both their gender and race/ethnicity. Except for Asian women, the earning disadvantages of all minority women's groups relative to white men were larger than the earning difference between white women white men.

Another study examining the earnings of minority women scientists and engineers find that the "double bind" or "double penalty" effect does not work the same way for different groups of minority women. Tang (1997) uses the 1989 Survey of Natural and Social Scientists and Engineers and compares the earnings of native- and foreign-born white, Asian, and black female scientists and engineers with native-born white men. She finds that after controlling for personal, geographic, and human capital variables, both native-born black and white women scientists and engineers earn significantly less, but native-born Asian women do not earn less than their white male counterparts. More specifically, white women scientists and engineers earn less in computer sciences, social sciences, and engineering; Asian women earn less only in computer sciences; and black women earn less only in social sciences. Thus, native-born Asian women do not suffer from the "double bind" effect. Foreign-born Asian women (the sample does not have sufficient number of foreign-born black women for comparison) fare similarly as comparable native white women. Thus, Tang argues that minority women, native- or foreign-born, are not disadvantaged in the same way. She assigns the relative advantage of Asian women scientists and engineers over comparable white women to the "statistical discrimination" that Asians are good at scientific and technical tasks, and this statistical discrimination extends to Asian women. Yet, due to data limitation, Tang does not examine the effect of the origin of the highest degree. Another study finds that among Asian women, some groups earn less than comparable whites but others do not. Torres Stone et al. (2006) find that when education, English proficiency level, work hours and weeks, age, occupation, occupational segregation level, and migration cohort (compared with native-born workers) are controlled, Filipinas do not earn less but Asian Indian women earn less than their white counterparts.

Tang's findings challenge those in earlier studies, which report the earning disadvantages of women scientists and engineers. The differences in the findings may be explained by the fact that most early studies do not differentiate white women from women of other races/ethnicities. Their samples often consist of a large share of whites and a small share of observations from other race/ethnic groups and even a smaller share of minority women. Yet, Tang's study also confirms with others in that white women and black women do have earning disadvantages compared with white men.

2.2.4 Immigrant Scientists and Engineers in the U.S.

In addition to women and minority scientists and engineers, another line of research has focused on foreign-born students and workers in S&E in the U.S. NSB (2008) shows that in 2003, 2.2 million foreign-born S&E degree holders stayed in the U.S., and 27% of them were from India (16%) and China (11%). Among them, 276,000 had doctorates, and 36% of them were from China (22%) and India (14%).

Many of these foreign-born S&E students stay in the U.S. after receiving their degrees. Finn (2007) reports that in 2005, 66% of temporary residents receiving U.S. S&E doctorates in 2003 remained in the U.S., decreasing from 71% in 2003 of 2001 S&E

doctorate recipients. The highest stay rates were found in computer and electrical and electronic engineering, and the lowest stay rates were found in agricultural sciences, economics, and other social sciences. Chinese (92%) and Indians (85%) were the two nationality groups with the highest stay rates.

The immigrant scientists and engineers have not only satisfied the demand for highly skilled workers in S&E (NSB 2008) but also have made great contributions to the U.S. S&E development. Stephan and Levine (2001) find that foreign-born or foreign-educated scientists (with a doctoral or medical degree) and engineers (with at least a baccalaureate degree) are overrepresented in scientists and engineers who make exceptional contributions to their fields in the U.S. Exceptional contributions refer to one of the following six criteria: being members of the National Academy of Science and/or Engineering, being among the authors of 250 most cited papers, of citation classics, or of highly cited patents, and being scientists who have been essential in the launch of biotechnology firms. Among all the foreign-born and foreign-educated, China and India are among the top six sending countries of such scientists and engineers who have made exceptional contributions across the six criteria.

Scholars have explained why S&E attract such a large number and proportion of immigrants. West and Bogumil (2001) assert that the international migration of computer scientists and engineers is facilitated by the shortage of information technology (IT) workers in many world regions. Among all regions, the U.S. is more attractive than others in terms of more employment opportunities, higher financial returns to their skills, and more opportunities of being involved in exciting, challenging, and innovative work activities that benefit workers in building up their skills and resume. Even after adjusting living costs, IT immigrants can still more easily live comfortably, support a family, and save money than in their home countries or other world regions.

Other scholars have investigated concerns for increasing the participation of U.S. citizens rather than relying heavily on immigrants to solve the shortage of S&E workers. Fechter and Teitelbaum (1997) argue that while studies find that immigrants have made great contributions to science and engineering in the U.S., it is hard to assess whether immigration if good or bad to the U.S. Immigrants who are willing to work for relatively low pay keep salaries low in science. Furthermore, U.S.-born students have fewer graduate training and job opportunities due to competition from foreign-born talent. But the larger question is why S&E occupations are unattractive to American students. Teitelbaum (2003) asserts that pursuing a career in science implies very high personal costs. Science requires lengthy training in graduate schools and at postdoctoral positions—for instance, seven years to receive the Ph.D. and two to five years of postdoc apprenticeship in biosciences. This means that scientists can not start their career until in their early thirties or older and not secure tenure until in their late thirties. The lengthy training is also related to the work-family conflict. In addition, doing science has huge opportunity costs. The nine to 12 years of doctoral and postdoctoral training means that a large amount of lifetime income is forgone. For instance, a bioscientist can lose $1 million compared with a medical doctor. When compared with MBA recipients from the same university, a bioscientist can lose $1 million of lifetime earnings, excluding stock options, or $2 million, including stock options. Teitelbaum argues that the relative attractiveness does not have as huge an impact on immigrants, at least those from less developed countries, because they tend not to choose to study law, medical, or business due to high costs and no subsidies. To attract qualified American students into S&E rather than law, medicine, or business school, efforts should be made on the demand side to make these fields more attractive. Freeman (2004) asserts that immigration in science is a blessing because they provide a pool of bright students and workers in S&E and strengthen the U.S. competitiveness in scientific and high-tech fields. But it is also a problem because it heightens competition with U.S. citizens and lowers wages and jobs.

In addition to what adults think about immigration, Rashid (2008) analyzes why American youth do not find scientific and engineering fields attractive. Talks with high school and college students across the country reveal several factors. The first barrier to American youth's interests in computer science and computer engineering is the stereotype that computer scientists work alone with computers, writing codes. This problem is more acute among women students who believe that they will not enjoy the work. Those who switch from computer-related majors to other majors perceive it a boring task involving debugging codes. The other major barrier is the perception following the doc-com downturn that these jobs will be outsourced soon and not many jobs will be available. Rashid argues that challenges in recruiting U.S. youths into computer science and engineering will persist without policy interventions.

For immigrants scientists and engineers, despite their contributions, do not always fare as well as their native-born counterparts. Daneshvary (1993) finds that in 1979, among natives and immigrants with at least a college degree, excluding the self-employed and the disabled, no differentials in returns to education and U.S. work experience existed. He asserts that earning differentials due to country-specific human capital may be smaller for workers with at least a college degree because college education is less country-specific than other forms of human capital. Furthermore, about half of the immigrant professionals have received formal training in the U.S. before working in the U.S. However, Espenshade, Usdansky, and Chung (2001) find that when education, employment locations, field, age, marital status, race/ethnicity, class, and industry are controlled, foreign-born scientists and engineers earned less than their native counterparts by 4.4% in 1989 and 9.3% in 1996.

Immigrant women fare worse than native-born women, when compared with their male counterparts. Xie and Shauman (2003) find that after age, race, education, field, sector, family status, and English proficiency are controlled, while native-born women are not disadvantaged relative to their male counterparts, foreign-born women scientists and engineers have 59% as high odds of employment as those of men and 32% as high odds of promotion as men. The gender difference among immigrants may be explained by the fact that immigrant women scientists often occupy less desirable and competitive positions. But in terms of earnings, Xie and Shauman find that native-born and immigrant women scientists and engineers are not paid significantly differently relative to their male counterparts. When age, race, education, field, sector, family status, English proficiency, and weeks and hours worked are controlled, native-born and immigrant women scientists and engineers earn 11% and 12% less than their male counterparts, respectively.

The review of the relevant literature shows that structural forces at various levels are at play. Some of the forces are societal, and others are unique to science and engineering. In general, white women, minorities, and minority women fare less well than their white and/or male counterparts in S&E. As racial/ethnic minority members, Asians can suffer from disadvantages in various aspects of their careers, including earnings. As the members of both a racial/ethnic minority group and women, Asian women may suffer from both their race and gender in earnings.

2.2.5 Limitations of the Literature

Yet, the literature has limitations. First, studies of Asians in S&E fields are relatively few and many of them are dated. They do not always distinguish native-born from foreign-born Asians and reveal the effects of race (Asian vs. white) and nativity (U.S.- vs. foreign-born). Also, most of these studies focus on the “glass ceiling” to advancement, and few studies (except Tang 1997) focus on their earning disparities due to their personal characteristics or gender differences in earnings, while controlling for other variables. Also, studies on Asians scientists and engineers tend not to disaggregate them by ethnicities of nationalities (if immigrants).

Furthermore, studies on women tend to focus on white women and those on minorities tend to focus on minority men. Not many studies examine Asian women scientists and engineers. In addition, some factors remain unexplored. As the region-specific human capital theory argues, the origin of highest education is a determining factor for earnings and the earning disparity between comparable immigrant and native workers. Partly due to the limitation of data, studies of Asian and immigrant scientists and engineers do not investigate the effect of the origin of the highest degree.

Meanwhile, studies on the earnings of scientists and engineers do not examine the effect of time—whether the pay gap between Asians with different backgrounds and comparable whites changed over time. Studies on women and minority scientists and engineers report that the earning gap between men and women and the employment opportunities between whites and blacks more or less narrowed over time (Long 2001;

Pearson 1985). Yet, we do not know whether the earning differences, if any, between Asians of different backgrounds (*e.g.*, nativity, the origin of the highest degree, and gender) and U.S.-born whites narrowed over time.

In addition, studies of Asian scientists and engineers do not discuss nationality or ethnic differences. Studies of Asian workers of all occupations show that both Asian Americans of different ethnicities and Asian immigrants of different nationalities have internal differences in earnings (e.g., Zeng and Xie 2004; Sharpe and Abdel-Ghany 2006). Thus, it is important to investigate the effect of ethnicities or nationalities on the earnings of Asian scientists and engineers. Now I turn to the chapter that addresses the statement of problems and hypotheses.

CHAPTER 3

HYPOTHESES

3.1 Statement of Problem

The purpose of this study is to contribute to our understanding of the earnings of Asian computer scientists and engineers. More specifically, it examines the effects of some characteristics, such as race, nativity, origin of the highest degree, and gender on the earnings of full-time, college-educated, salaried Asian computer scientists and engineers. For all the above effects, this study tests whether they changed from 1993 to 2003. The gap between 1993 and 2003 is large enough to see the changes of the above effects, yet, it is not too long to miss important changes during the period.

Although this research design draws heavily on that of Zeng and Xie's (2004) work, it differs in some notable aspects. Zeng and Xie focus on males, while this study examines both males and females. They use foreign nativity and education, but this study uses Asian nativity and highest education. As a variable, foreign education is more diverse than Asian education and may not be consistently evaluated in the U.S. For instance, while some foreign countries use English as the language of instruction and have similar educational models to that of the U.S., others do not. In addition, education in different Asian countries, especially in S&E, is more or less similar in quality. For one, Asian countries, with few exceptions, do not use English as the language of instruction. Meanwhile, Asian education has similar advantages (*e.g.*, the societal high regard and expectation for education) and disadvantages (*e.g.*, the emphasis on memorization and repetition at the cost of creativity) (Kim 2005). But these characteristics of education may not apply in some countries or other world regions (e.g., Africa, South America, and parts of Europe). In addition, while they examine workers of all occupations with all levels of education, this study focuses on computer scientists and engineers with bachelor's or higher degrees to understand dynamics within these two specific fields.[3]

3.2 Hypotheses

Based on the theories and the findings of the previous literature in S&E and scientists and engineers reviewed above, this study tests the following hypotheses. All the hypotheses are tested while relevant variables are controlled.

3.2.1 Hypotheses Related to the Net Effects of Race, Nativity, and Degree Origin

Previous studies show that for Asian workers in the U.S., race and nativity do not have statistically significant effects on earnings, but the place of education does. They also reveal that opportunity structures for women and racial/ethnic minorities in S&E slightly improved over time. For Asian computer scientists and engineers, the origin of the highest degree may have a statistically significant effect on their earnings, but its effect may decrease over time. Thus, the first set of hypotheses is as follows:

1a. Race and nativity have less strong effects on Asian computer scientists and engineers' earnings than the origin of the highest degree.

1b. The effect of the origin of the highest degree narrows over time (from 1993 to 2003).

3.2.2 Hypotheses Related to Gender

The effect of the origin of the highest degree may be strong enough to work for both men and women. Furthermore, most early studies report gender differences in S&E.

Thus, the gender difference may also exist among Asians of different backgrounds. In addition, although male- and white-dominated positions do not necessarily involve the devaluation of women and minorities, previous research shows that scientific and engineering positions pay men more than women and whites more than minorities. Furthermore, although findings are mixed, minority women tend to experience disadvantages in S&E. The second set of hypotheses is as follows:

2a. The effect of the origin of the highest degree exists among both men and women.

2b. Asian female computer scientists and engineers earn significantly less than their male counterparts in each group.

2c. Women of some Asian groups experience the double bind effect.

2d. The above differences narrow over time.

3.2.3 Hypotheses Related to Field

The effects of degree origin may be strong enough to work among both computer scientists and engineers. Also, field differences may exist in payment. Although both computer science and engineering are well-paid fields, and previous studies have not examined earning differences in these two fields, we may find that they pay comparable workers differently. In other words, one field may pay workers who are otherwise the same slightly more than the other. But these effects may diminish over time. Thus, I test the following third set of hypotheses:

3a. The effect of the origin of the highest degree exists among both computer scientists and engineers.

3b. Asian computer scientists and engineers have statistically significant differences in earnings.

3c. The above differences narrow over time.

3.2.4 Hypotheses Related to Employment Sector

Again, the effects of degree origin may be strong enough to work in all the employment sectors. Furthermore, earlier studies have shown that different sectors have different structures of rewarding workers, and some sectors pay comparable workers more than others. However, these effects may diminish over time. The following is the fourth set of hypotheses:

4a. The effect of the origin of the highest degree exists across sectors, namely in educational institutions, industry, and government.

4b. Asian computer scientists and engineers earn significantly more in industry than in educational and government settings.

4c. The above differences narrow over time.

3.2.5 Hypotheses Related to Nationality

Studies have shown that Asians of different ethnicities or nationalities differ from each other in many aspects. While Asian-educated immigrant computer scientists and engineers may earn less than their U.S.-educated counterparts due to their degree origin, not all of them may do so. In other words, Asian-educated immigrants of some nationalities may earn less than their U.S.-educated counterparts but those of other nationalities may not. Furthermore, they may have statistically significant earning differences from whites. In addition, literature on the region-specific human capital suggests that among foreign-educated workers, those from English-speaking and economically developed regions and nations earn more than those from non-English-speaking and economically less developed places. Then, some Asian-educated nationality groups may earn more than others although all of them received highest degrees in Asia. Thus, the fifth set of hypotheses is as follows:

5a. Of some but not all nationality groups, the U.S.-educated earned more than their Asian-educated counterparts.

5b. Of Asian-born computer scientists and engineers, U.S.- or Asian-educated, some nationality groups earn significantly less than whites while others do not.

5c. Asian-born computer scientists and engineers, U.S.- or Asian-educated, also have different earning patterns among themselves. Some nationality groups (those from relatively less-well developed or non-English speaking nations) earn significantly less than others.

5d. The above differences narrow over time.

CHAPTER 4

METHODOLOGY

4.1 Data

Data are obtained from the National Survey of College Graduates (NSCG) conducted by the National Science Foundation. The NSCG data sets have nationally representative samples of individuals with at least a bachelor's degree in S&E or S&E-related fields and working in those fields. The samples of the surveys include computer scientists and engineers who were born and earned their degrees in or outside the U.S. less than 76 years of age. To examine the change over time, this study examines public data collected in both 1993 and 2003.

Figures 4.1 and 4.2 show the compositions of the 1993 and 2003 samples. In total, the 1993 sample has 11,739 engineers and 5,985 computer scientists. The 2003 sample contains 7,334 engineers and 6,889 computer scientists. The difference between the numbers of engineers in the 1993 and 2003 samples is due to differences in stratification and sampling strategy for the survey. The largest group in both years was male engineers, representing 61% of the 1993 sample and 46% of the 2003 sample. The smallest group in both years was female engineers, accounting for 5% of the samples in both years. Engineering has the largest gender gap in participation. Among computer scientists, male outnumbered females in both years. Male and female computer scientists represented 24% and 9% of the 1993 sample, respectively, and 36% and 13% of the 2003 sample, respectively.

In the four groups, as Table 4.1 shows, among both males and females, whites made up the largest share of either engineers or computer scientists in either year. The second largest group is U.S.-educated immigrants. The other two groups, Asian Americans and Asian-educated immigrants are much smaller in size.

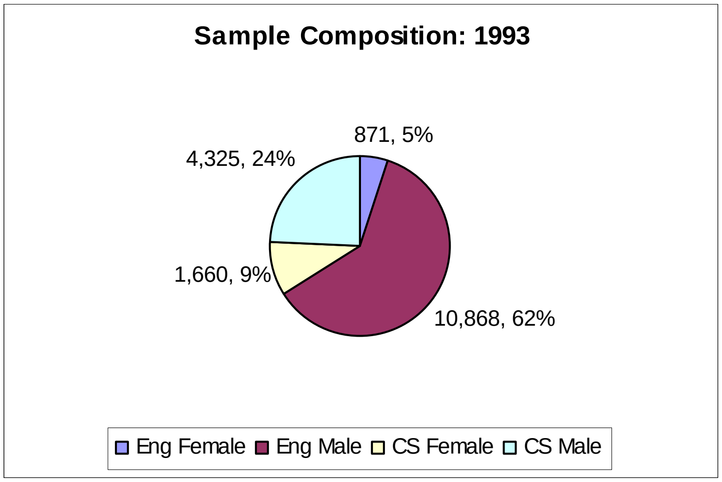

Figure 4.1

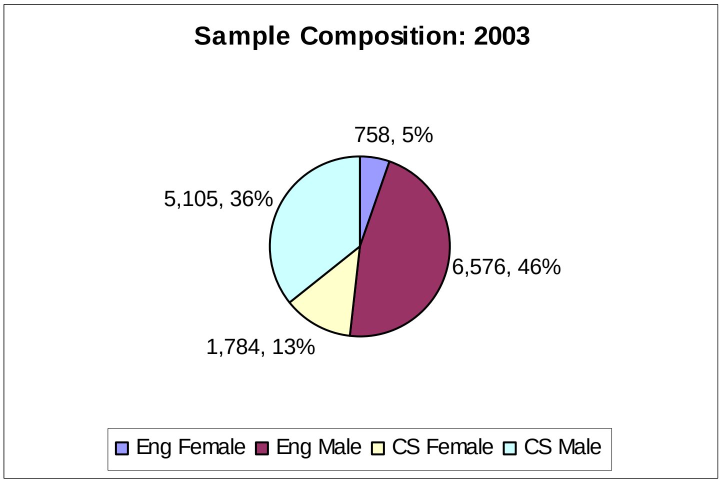

Figure 4.2

The NSCG survey began in 1993, and the sample with bachelor's or higher degrees was derived from the 1990 census. However, individuals who received another (the highest) degree from 1991 to 1993 were also included. The 2003 sample used the

2000 census sample and the 2001 National Survey of Recent College Graduates (NSRCG) sample. NSRCG is another data set of NSF. Similar to the 1993 NSCG sample, the 2003 NSCG sample includes people who received their degrees by April 1, 2000 and also from 2001 through 2003. One caution is that foreign-educated people in the sample were not well covered.[4] Therefore, care should be given in interpreting the representativeness of this group. Nevertheless, due to limited attention paid to the effect of the origin of the highest degree on the earnings of S&E workers, examining this effect is worthwhile.

Table 4.1. The Composition of the Samples, 1993 and 2003

			Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants	Total
1993	Engineers	Male	9295	257	1002	314	10868
		Female	717	43	79	32	871
	C.S.	Male	3675	113	453	84	4325
		Female	1331	71	206	52	1660
	Subtotal		15018	484	1740	482	17724
2003	Engineers	Male	5306	166	884	220	6576
		Female	572	32	127	27	758
	C.S.	Male	3692	129	856	428	5105
		Female	1299	42	334	109	1784
	Subtotal		10869	369	2201	784	14223
Total			25,887	853	3,941	1,266	31,947

Notes: Both whites and Asian Americans are U.S.-born and U.S.-educated. Both U.S.- and Asian-educated immigrants are Asian-born.

4.2 Procedures and Analyses

All whites in this study are non-Hispanic U.S.-born citizens. Asians' classification is self-reported, non-Hispanic Asians who were born in the U.S. or in Asia and were U.S. citizens (native-born or naturalized), permanent residents, or temporary residents.[5] They are classified into three major groups based on their nativity and the origin of the highest degree: (1) U.S.-born Asian Americans (referred to as Asian Americans); (2) Asian-born, U.S.-educated Asian immigrants (referred to as U.S.-educated immigrants); and (3) Asian-born, Asian-educated Asian immigrants (referred to as Asian-educated immigrants).

The sample focuses on computer scientists and engineers working in all types of employment sectors in the U.S. All subjects included in this study were full-time workers who reported their highest degrees as bachelor’s, master’s, or doctorates from U.S. or Asian institutions. Data on individual ethnic groups for U.S.-born Asian Americans are unavailable. Consequently, I do not analyze Asian ethnic differences but nationality differences for the Asian-born.

In understanding the effects of race, nativity, and the origin of the highest degree on scientists and engineers’ salaries, this study adapted a version of Zeng and Xie’s research design (see Figure 4.3). If, net of other factors, results show significant differences in salaries between whites and Asian Americans, the net effect of race exists. If significant earning differences exist between Asian Americans and U.S.-educated immigrants, the net effect of nativity exists. If the findings reveal significant earning differences between U.S.- and Asian-educated immigrants, the net effect of degree origin is at play. Pairwise t-tests (or linear combinations of estimators) can show whether two groups’ coefficients are significantly different.

U.S.-born, U.S.-educated Whites

The effect of race

U.S.-born, U.S.-educated Asian Americans

The effect of nativity

Asian-born, U.S.-educated Immigrants

The effect of the origin of the highest degree

Asian-born, Asian-educated Immigrants

Figure 4.3. Research Design: Examining the Effects of Race, Nativity, and Degree Origin

I choose computer scientists and engineers because Asians are overrepresented in both fields. As a result, enough observations in the sample exist for meaningful statistical analysis. Furthermore, these fields provide good examples to determine whether a racial/ethnic minority can achieve the same level of attainment as whites in scientific occupations in which they are overrepresented. In addition, both are male-dominated, and I can test whether women fare similarly in both fields. This study also tests the effects of the three factors across sector.

To understand whether the above effects and the changes over time are statistically significant, this study uses quantile regression to examine the effects of the factors at different quantiles of responses. More specifically, this study uses .90 and .50 quantile. The dependent variable in this study is the natural logarithm of the annualized salary.[6] The key independent variables include race, nativity, and the origin of the highest degree. To understand the effects of these and other variables, I control for personal, educational, and employment characteristics.

Personal characteristics include gender, marital status, having at least a child, age, age-squared, citizenship status, and the interaction terms of gender and being married and of gender and having children. Studies have shown that being married and having children can also influence a scientist's or an engineer's performance, which may be related to their earnings. Older age often leads to higher salaries, and the age-square variable is used to determine whether salary increases or decreases in a linear or nonlinear way. Citizenship status is potentially important in that they can be proxies of the level of assimilation, which may influence earnings (Tang 1997). Previous studies also show that marriage and children have different impact on the career advancement of women than on that of male scientists. The interaction terms can test the different effects of marriage and children on men and women.

Educational characteristics include the degree level (*i.e.*, bachelor's, master's, doctoral, excluding professional degrees) and the field of the highest degree. Different degree levels should yield different earnings, as the human capital theory holds (Schultz 1961; Becker 1993). Engineers trained in fields other than engineering may have qualifications different from those trained in engineering programs, which may influence their salaries.

Employment characteristics include individual and employer characteristics. Individual characteristics include work experience, experience-squared, being a supervisor, the field of the occupation, and principal work activities. Similar to age, longer work experience often leads to an increase in the salary, and its square term can show whether this increase is linear or curvilinear. Since experience is a proxy of years since the highest degree, age can capture some of the mismeasurement of experience. Supervisors often earn more than non-supervisor workers, and different principal work activities typically lead to different salaries, especially if one compares those whose work activity is management and those whose main activity is teaching. The field may also make a difference.

Employer characteristics set apart employers who are different in sector and location. In industry, self employment may reward workers differently from non-profit and for-profit organizations (Barringer et al. 1990). Some areas, such as New England and the Pacific area, have higher living costs than others, and thus, employees are expected to earn more in those areas.

To understand the effect of race, first of all, after running a quantile regression, I run pairwise tests to determine whether the differences in the coefficients of the two groups, whites and Asian Americans, are statistically significant. Furthermore, I calculate the difference in the coefficients of these two groups (*e.g.*, $d_1 = Y_2 – Y_1$) and exponentiate the difference [*e.g.*, $r = \exp(d_1)$] to get the ratio of the second group to the first.

(1) $d_k = Y_{k+1} – Y_{k,}$ with k=1, 2, 3

(2) $r = \exp(d_k)$, with k=1, 2, 3

Similarly, to understand the effects of nativity and degree origin, I test to see whether the differences in coefficients are statistically significant, and if so, calculate the difference in the coefficients of U.S.-educated immigrants and Asian Americans ($d_2 = Y_3 – Y_2$) and that of Asian- and U.S.-educated immigrants ($d_3 = Y_4 – Y_3$) and exponentiate the coefficient differences [$\exp(d_2)$ and $\exp(d_3)$].

CHAPTER 5

DESCRIPTIVE RESULTS

This chapter describes the demographic characteristics and the annualized salaries of U.S.-born whites (or whites), U.S.-born Asian Americans (or Asian Americans), Asian-born, U.S.-educated Asian immigrants (or U.S.-educated immigrants), and Asian-born, Asian-educated Asian immigrants (or Asian-educated immigrants) in 1993 and 2003. All of them were full-time, college-degreed engineers and computer scientists. The demographic characteristics include, for both men and women, each group's total number, mean ages, mean years since the highest degree, the mean percentages of supervisors and managers, and the ethnic composition of the Asian-born for each gender and each occupational field in the 1993 and 2003 samples.

This chapter also describes and compares the mean salaries of each group at each degree level for both computer scientists and engineers in 1993 and 2003.

5.1 Overview of Some Demographic Characteristics of Engineers

In 1993, among full-time male engineers, U.S.-educated immigrants had the highest mean salaries (in 2003 dollars), and Asian-educated immigrants had the lowest (Table 5.1). As a group, the latter were the oldest and had the largest proportion of being married and having at least one child. Asian Americans had the lowest proportions of being married and having children. In terms of citizenship status, most of the immigrants were naturalized U.S. citizens, followed by permanent and then temporary residents.

Table 5.1. Mean Characteristics of Full-time White and Asian Male Engineers, 1993

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	9,295	257	1,002	314
Mean annual salary	$ 70,338	$ 69,787	$71,886	$63,185
Mean age	41.5	41.4	41.7	46.3
% Married	79.7	63.0	85.1	94.9
% Having children	56.8	40.9	69.9	81.2
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	74.6	67.8
% Permanent residents	--	--	21.3	23.3
% Temporary residents	--	--	4.2	8.9
Degree Level				
% Bachelor's as the highest degree	72.0	70.4	27.2	83.4
% Master's as the highest degree	25.5	29.2	50.5	14.7
% Doctorate as the highest degree	2.6	0.4	22.4	1.9
Employment Sector				
% Educational institutions	2.4	1.9	8.4	6.4
% For-profit firms	78.9	64.2	74.3	72.3
% Self-employment	1.8	3.1	1.3	1.3
% Non-profit organizations	1.2	--	1.0	0.6
% Federal government	10.2	18.3	8.6	4.8
% State/local government	5.4	12.5	6.5	14.7
Mean years since the highest degree	15.4	16.2	12.2	21.8
% Supervisor	51.3	46.7	47.6	42.7
Primary work activities				
% Research and development	49.4	44.8	58.5	49.4
% Teaching	1.1	1.6	3.0	2.2
% Management and administration	25.0	26.1	13.8	18.8
% Computer application	9.5	12.1	14.4	9.9
% Other work activities	15.0	15.6	10.4	19.8
Employer Region				
% New England	7.2	--	5.0	1.9
% Middle Atlantic	13.2	6.6	15.8	19.1
% East North Central	17.5	5.1	12.8	15.0
% West North Central	6.4	1.6	2.9	1.6
% South Atlantic	16.3	3.9	10.8	8.6
% East South Central	5.2	1.2	3.1	1.9
% West South Central	10.5	1.2	9.5	6.4
% Mountain	7.4	4.7	2.7	1.6
% Pacific	16.3	75.9	37.5	44.0
Nationality of Asian-born engineers				
% Chinese *			24.6	7.6
% Indian			31.1	27.1
% Taiwanese			15.5	3.2
% Japanese			1.7	6.1
% Korean **			5.9	6.4
% Filipino			2.1	40.1
% Vietnamese			11.4	3.2
% Others			7.8	6.3

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 1993
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

In terms of educational attainment, the Asian-educated had the highest proportion of bachelor's as the highest degree, and U.S.-educated immigrants had the highest shares of the master's and the doctorate. This fact may partly explain the fact that the Asian-educated earned less than U.S.-educated immigrants in 1993.

In terms of employment sectors, the largest proportion of each of the three Asian groups and whites worked in for-profit firms. U.S.-educated immigrants had a higher proportion of working in educational institutions than other groups. A higher proportion of Asian Americans than other groups worked in federal government, but proportionately more Asian-educated immigrants than others worked in state or local government. In terms of work experience, Asian-educated immigrants had the longest years, which is not surprising since they were the oldest group with the largest proportion of having bachelor's as the highest degree. They were also the group with the lowest proportion of supervisors. The group with the largest share of supervisors was whites.

In terms of the type of primary work activities, U.S.-educated immigrants had larger shares of working on research and development, teaching, and computer application and smaller shares on management and administration than other groups. This fact confirms Tang's (2000) finding that in academia, foreign-born Asian engineers are more likely to work in R&D, their niche field. Foreign-born Asian engineers are believed to be interested in and good at conducting technical tasks but not management positions.

In terms of residential patterns, a notable phenomenon is that while whites are dispersed throughout the country, Asians are concentrated in a few regions. The Asian groups, especially Asian Americans, highly concentrate in the Pacific region—75.9% of Asian American male engineers worked in the Pacific in 1993.

Among Asian-born male engineers, Indians were the largest group among those educated in the U.S., followed by those born in China (including mainland China, Hong Kong, and Macao) and Taiwan. Among those educated in Asia, Filipinos were the largest, followed by those born in India and China.

In 2003, most of the characteristics of the sample for male engineers were similar to those in the 1993 sample (Table 5.2). Some changes include that the group with the largest proportion of the bachelor's as the highest degree was whites, followed closely by Asian-educated immigrants, and that the group with the largest share of managers or administrators were whites rather than Asian Americans. Among the Asian-educated, the largest nationality group was Indians, followed by Filipinos (the largest group in 1993) and the Chinese.

Table 5.2. Mean Characteristics of Full-time White and Asian Male Engineers, 2003

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	5,306	166	884	220
Mean annual salary	$ 79,983	$ 83,313	$84,853	$77,745
Mean age	44.5	41.6	43.8	47.3
% Married	82.8	68.7	87.0	93.6
% Having children	57.9	55.4	63.3	69.1
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	70.9	58.2
% Permanent residents	--	--	19.5	26.4
% Temporary residents	--	--	9.6	15.5
Degree Level				
% Bachelor's as the highest degree	69.4	59.6	22.3	65.5
% Master's as the highest degree	26.2	33.1	49.2	23.6
% Doctorate as the highest degree	4.4	7.2	28.5	10.9
Employment Sector				
% Educational institutions	3.2	3.6	7.0	3.6
% For-profit firms	80.3	72.9	78.4	75.9
% Self-employment	2.3	1.8	1.7	2.7
% Non-profit organizations	1.0	0.6	1.0	0.5
% Federal government	7.6	15.7	5.0	3.6
% State/local government	5.7	5.4	6.9	13.6
Mean years since the highest degree	17.7	15.8	13.9	22.7
% Supervisor	50.8	41.0	41.2	42.3
Primary work activities				
% Research and development	47.7	48.2	57.9	57.3
% Teaching	1.4	0.6	2.7	--
% Management and administration	33.2	25.3	20.7	25.5
% Computer application	5.9	10.8	11.5	6.8
% Other work activities	11.8	15.1	7.1	10.5
Employer Region				
% New England	7.7	4.2	4.6	3.2
% Middle Atlantic	10.0	9.0	12.0	11.8
% East North Central	19.2	10.8	17.5	18.2
% West North Central	7.4	1.2	2.6	2.3
% South Atlantic	16.6	10.2	10.4	11.4
% East South Central	5.8	--	2.0	1.8
% West South Central	10.1	4.2	10.4	5.9
% Mountain	8.3	3.0	3.1	2.3
% Pacific	14.9	57.2	37.3	43.2
Nationality of Asian-born engineers				
% Chinese *			24.7	14.1
% Indian			28.3	38.2
% Taiwanese			13.5	5.5
% Japanese			1.6	7.7
% Korean **			6.7	3.2
% Filipino			2.8	24.1
% Vietnamese			10.0	1.4
% Others			12.6	5.9

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 2003
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

One obvious change between 1993 and 2003 was the number of observations in the sample. The number of each group in 2003 was smaller than that in 1993, but the decrease of whites were the greatest. This drop could be due to differences in stratification and sampling strategy for the survey. However, it also coincided with the drop of white males in receiving S&E degrees in the U.S. Although the exact numbers of engineers over the period are not available, data show that from 1990 to 2000, bachelor's and master's degrees in engineering awarded to white male U.S. citizens and permanent residents decreased from 51,455 in 1990 to 40,768 in 2000 (see the "IPEDS Completions Survey by Race" at the NSF WebCaspar database; no data available for only U.S. citizens). The doctoral degrees awarded to white male U.S. citizens slightly decreased in the decade from 1,474 in 1990 to 1,446 in 2000. This decrease is more obvious in the context of increasing numbers of S&E doctorates awarded to females and other racial/ethnic groups during the same period (see NSF Survey of Earned Doctorates/Doctorate Records File at the NSF WebCaspar database).

Female engineers in the sample had similar characteristics to male engineers in many aspects but different in some notable aspects. In both 1993 and 2003, the group that earned the highest salaries was Asian Americans instead of U.S.-educated immigrants (Tables 5.3 and 5.4). Also, in 1993, the group that had a higher proportion of working in educational institutions was Asian-educated immigrants rather than U.S.-educated immigrants. In 2003, different from male engineers in the same year, the group that earned the highest share of doctorates as the highest degree was Asian Americans. They were also the group that had a higher proportion of mangers and administrators than other groups. This fact, along with others, such as the highest percentage of doctorates as the highest degree, may account for their highest earnings among the four groups.

From 1993 to 2003, an overall change for both male and female engineers was that the proportion of graduate degrees increased. Furthermore, the nationality distribution of female Asian-born engineers was quite different from that of males. Among the U.S.-educated, some large groups were the Chinese, Indians, and the Vietnamese, but among the Asian-educated, the Chinese, Indians, and Filipinos. Nevertheless, the numbers of female Asian-educated immigrants and Asian Americans were quite small in both years. Other demographic aspects experienced some minor changes from 1993 to 2003.

Table 5.3. Mean Characteristics of Full-time White and Asian Female Engineers, 1993

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	717	43	79	32
Mean annual salary	$59,738	$64,882	$60,557	$58,176
Mean age	34.0	35.1	35.2	43.9
% Married	62.2	62.8	72.2	81.3
% Having children	33.5	48.8	59.5	75.0
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	72.2	78.1
% Permanent residents	--	--	22.8	15.6
% Temporary residents	--	--	5.1	6.3
Degree Level				
% Bachelor's as the highest degree	71.7	65.1	49.4	75.0
% Master's as the highest degree	26.8	32.6	38.0	18.8
% Doctorate as the highest degree	1.5	2.3	12.7	6.3
Employment Sector				
% Educational institutions	1.8	--	7.6	12.5
% For-profit firms	76.9	53.5	69.6	65.6
% Self-employment	0.7	--	--	--
% Non-profit organizations	1.3	7.0	2.5	--
% Federal government	11.3	27.9	10.1	3.1
% State/local government	8.1	11.6	10.1	18.8
Mean years since the highest degree	8.8	9.9	8.2	19.3
% Supervisor	39.1	30.2	38.0	25.0
Primary work activities				
% Research and development	46.7	39.5	53.2	46.9
% Teaching	1.1	--	3.8	3.1
% Management and administration	24.0	27.9	7.6	21.9
% Computer application	9.9	16.3	24.1	12.5
% Other work activities	18.3	16.3	11.4	15.6
Employer Region				
% New England	7.1	2.3	5.1	3.1
% Middle Atlantic	14.1	11.6	19.0	15.6
% East North Central	15.6	--	6.3	15.6
% West North Central	4.5	2.3	--	6.3
% South Atlantic	15.9	11.6	11.4	9.4
% East South Central	4.9	--	2.5	--
% West South Central	11.3	--	11.4	9.4
% Mountain	7.1	7.0	5.1	--
% Pacific	19.5	65.1	39.2	40.6
Nationality of Asian-born engineers				
% Chinese *			27.9	18.8
% Indian			11.4	21.9
% Taiwanese			12.7	3.1
% Japanese			2.5	6.3
% Korean **			8.9	--
% Filipino			7.6	46.9
% Vietnamese			19.0	--
% Others			10.1	3.1

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 1993
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

Table 5.4. Mean Characteristics of Full-time White and Asian Female Engineers, 2003

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	572	32	127	27
Mean annual salary	$69,652	$78,188	$73,843	$67,037
Mean age	37.9	37.6	37.6	46.6
% Married	63.3	78.1	75.6	85.2
% Having children	44.8	53.1	59.8	55.6
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	74.8	63.0
% Permanent residents	--	--	18.1	25.9
% Temporary residents	--	--	7.1	11.1
Degree Level				
% Bachelor's as the highest degree	62.4	50.0	35.4	70.4
% Master's as the highest degree	32.9	34.4	50.4	18.5
% Doctorate as the highest degree	4.7	15.6	14.2	11.1
Employment Sector				
% Educational institutions	4.6	3.1	4.7	7.4
% For-profit firms	74.0	56.3	83.5	77.8
% Self-employment	1.9	--	0.8	--
% Non-profit organizations	0.9	3.1	2.4	--
% Federal government	8.9	15.6	3.2	3.7
% State/local government	9.6	21.9	5.5	11.1
Mean years since the highest degree	11.3	12.2	9.3	22.5
% Supervisor	46.0	37.5	31.5	29.6
Primary work activities				
% Research and development	41.1	40.6	61.4	51.9
% Teaching	1.6	--	1.6	--
% Management and administration	38.3	50.0	18.9	29.6
% Computer application	4.7	9.4	14.2	18.5
% Other work activities	14.3	--	3.9	--
Employer Region				
% New England	8.0	3.1	2.4	7.4
% Middle Atlantic	10.3	12.5	12.6	22.2
% East North Central	21.0	9.4	11.0	7.4
% West North Central	6.6	--	4.7	--
% South Atlantic	18.5	3.1	11.0	11.1
% East South Central	4.0	--	1.6	--
% West South Central	9.3	6.3	8.7	7.4
% Mountain	8.2	6.3	5.5	3.7
% Pacific	14.0	59.4	42.5	40.7
Nationality of Asian-born engineers				
% Chinese *			37.8	44.4
% Indian			14.2	25.9
% Taiwanese			6.3	--
% Japanese			2.4	--
% Korean **			5.5	--
% Filipino			7.9	25.9
% Vietnamese			18.9	--
% Others			7.1	3.7

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 2003
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

5.2 Overview of Some Demographic Characteristics of Computer Scientists

Among male and female computer scientists, many of the patterns were similar to those of male engineers in 1993 and 2003. Here, I highlight some different patterns. In both years and for both men and women, U.S.-educated immigrants consistently earned the most (Tables 5.5-5.8). This finding distinguishes women computer scientists from women engineers, of whom Asian Americans earned the most, without controlling for other variables.

In general, while Asian-educated engineers, male and female, were the oldest among all engineers in either year, Asian-educated computer scientists were not much older or even younger than other groups of computer scientists (Tables 5.5-5.8). Unlike their engineer counterparts, most of Asian-educated computer scientists were permanent residents, possibly as a result of their younger age relative to engineers.

For computer scientists, across gender and year, not surprisingly, the most common primary work activity was computer application. This fact, nevertheless, again distinguishes the computer scientists from the engineers, whose most common primary work activity was research and development. Furthermore, compared with engineers, proportionately more computer scientists worked in for-profit firms and fewer worked in government at any level.

Table 5.5. Mean Characteristics of Full-time White and Asian Male Computer Scientists, 1993

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	3,675	113	453	84
Mean annual salary	$ 68,398	$ 68,367	$71,513	$64,835
Mean age	39.7	37.2	37.7	39.9
% Married	74.0	62.0	78.8	89.3
% Having children	53.4	44.3	59.2	64.3
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	59.6	34.5
% Permanent residents	--	--	35.3	53.6
% Temporary residents	--	--	5.1	11.9
Degree Level				
% Bachelor's as the highest degree	71.1	69.0	31.8	71.4
% Master's as the highest degree	26.1	30.1	56.1	25.0
% Doctorate as the highest degree	2.8	0.9	12.1	3.6
Employment Sector				
% Educational institutions	5.4	6.2	6.8	3.6
% For-profit firms	79.1	79.7	83.0	86.9
% Self-employment	2.2	0.9	2.2	1.2
% Non-profit organizations	2.7	3.5	1.8	3.6
% Federal government	7.2	3.5	3.3	1.2
% State/local government	3.4	6.2	2.9	3.6
Mean years since the highest degree	13.4	11.9	9.2	15.7
% Supervisor	40.2	38.1	32.7	35.7
Primary work activities				
% Research and development	13.5	14.2	17.4	9.5
% Teaching	1.9	1.8	2.0	1.2
% Management and administration	12.2	7.1	6.4	16.7
% Computer application	67.0	74.3	72.0	67.9
% Other work activities	5.5	2.7	2.2	4.8
Employer Region				
% New England	9.0	3.5	6.6	6.0
% Middle Atlantic	15.4	9.7	16.6	32.1
% East North Central	14.9	5.3	11.0	9.5
% West North Central	5.8	3.5	5.1	2.4
% South Atlantic	18.7	8.9	9.1	7.1
% East South Central	3.1	--	1.1	1.2
% West South Central	9.2	1.8	9.7	--
% Mountain	6.9	4.4	3.5	2.4
% Pacific	17.0	62.8	37.3	39.3
Nationality of Asian-born computer scientists				
% Chinese *			21.2	8.3
% Indian			26.5	47.6
% Taiwanese			23.8	9.5
% Japanese			1.8	2.4
% Korean **			4.2	3.6
% Filipino			2.7	26.2
% Vietnamese			11.3	1.2
% Others			8.6	1.2

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 1993
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

Table 5.6. Mean Characteristics of Full-time White and Asian Male Computer Scientists, 2003

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	3,692	129	856	428
Mean annual salary	$ 78,411	$78,008	$84,423	$80,897
Mean age	42.8	36.8	39.2	36.8
% Married	77.3	57.4	83.8	91.1
% Having children	54.6	34.1	63.6	68.5
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	62.7	18.7
% Permanent residents	--	--	25.8	50.0
% Temporary residents	--	--	11.5	31.3
Degree Level				
% Bachelor's as the highest degree	71.6	74.4	25.5	60.1
% Master's as the highest degree	25.2	22.5	60.8	36.5
% Doctorate as the highest degree	3.2	3.1	13.8	3.5
Employment Sector				
% Educational institutions	6.6	7.8	5.4	1.6
% For-profit firms	79.6	83.7	86.2	91.8
% Self-employment	2.9	--	1.8	0.9
% Non-profit organizations	3.3	3.9	1.8	3.3
% Federal government	3.6	1.6	2.6	0.5
% State/local government	4.0	3.1	2.3	1.9
Mean years since the highest degree	15.7	12.0	10.4	13.4
% Supervisor	36.0	29.5	36.9	34.6
Primary work activities				
% Research and development	18.9	20.9	21.7	15.2
% Teaching	1.9	--	1.6	0.2
% Management and administration	17.5	17.1	10.8	8.6
% Computer application	56.4	56.6	61.7	73.4
% Other work activities	5.3	5.4	4.2	2.6
Employer Region				
% New England	8.0	9.3	5.4	6.5
% Middle Atlantic	12.7	11.6	17.6	21.7
% East North Central	15.2	7.0	12.2	13.8
% West North Central	8.7	3.1	3.5	3.5
% South Atlantic	19.6	7.0	13.9	15.4
% East South Central	3.2	--	2.0	1.6
% West South Central	9.1	8.5	9.1	6.1
% Mountain	8.9	7.0	2.5	3.7
% Pacific	14.7	46.5	33.9	27.6
Nationality of Asian-born computer scientists				
% Chinese *			28.0	8.6
% Indian			29.9	78.5
% Taiwanese			13.6	1.2
% Japanese			1.2	1.2
% Korean **			4.8	1.4
% Filipino			3.0	6.1
% Vietnamese			9.1	0.7
% Others			10.4	2.3

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 2003
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

Table 5.7. Mean Characteristics of Full-time White and Asian Female Computer Scientists, 1993

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	1,331	71	206	52
Mean annual salary	$61,749	$62,933	$65,287	$51,449
Mean age	38.4	37.4	36.9	44.7
% Married	60.4	57.8	79.6	78.8
% Having children	38.8	40.9	60.7	69.2
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	71.8	73.1
% Permanent residents	--	--	26.7	25.0
% Temporary residents	--	--	1.5	1.9
Degree Level				
% Bachelor's as the highest degree	72.4	83.1	40.8	84.6
% Master's as the highest degree	26.2	16.9	56.3	13.5
% Doctorate as the highest degree	1.4	--	2.9	1.9
Employment Sector				
% Educational institutions	7.7	12.7	4.4	1.9
% For-profit firms	76.8	63.4	85.4	76.9
% Self-employment	1.5	--	--	--
% Non-profit organizations	4.1	7.0	1.9	11.5
% Federal government	6.4	8.5	4.9	1.9
% State/local government	3.5	8.5	3.4	7.7
Mean years since the highest degree	12.4	13.4	9.4	21.7
% Supervisor	38.2	29.6	28.2	23.1
Primary work activities				
% Research and development	10.5	14.1	9.7	5.8
% Teaching	2.3	4.2	1.9	1.9
% Management and administration	15.2	11.3	7.8	15.4
% Computer application	65.7	64.8	75.2	73.1
% Other work activities	6.3	5.6	5.3	3.9
Employer Region				
% New England	9.5	2.8	3.9	1.9
% Middle Atlantic	15.4	11.3	22.8	11.5
% East North Central	13.5	2.8	7.3	7.7
% West North Central	7.0	1.4	2.4	3.9
% South Atlantic	19.5	4.2	14.1	21.2
% East South Central	3.9	1.4	1.5	--
% West South Central	9.0	4.2	7.8	7.7
% Mountain	6.1	5.6	1.9	1.9
% Pacific	16.2	66.2	38.4	44.2
Nationality of Asian-born computer scientists				
% Chinese *			27.7	7.7
% Indian			12.6	25.0
% Taiwanese			29.1	17.3
% Japanese			5.3	--
% Korean **			7.3	3.8
% Filipino			1.9	36.5
% Vietnamese			11.7	3.9
% Others			4.4	5.8

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 1993
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

Table 5.8. Mean Characteristics of Full-time White and Asian Female Computer Scientists, 2003

Variable	Whites	Asian Americans	U.S.-educated Immigrants	Asian-educated Immigrants
Number	1,299	42	334	109
Mean annual salary	$68,019	$ 68,571	$75,246	$70,862
Mean age	43.0	39.2	39.5	36.9
% Married	60.1	42.9	82.3	89.0
% Having children	43.1	33.3	64.7	69.7
Citizenship Status				
% native-born U.S. citizens	100.0	100.0	--	--
% naturalized U.S. citizens	--	--	67.4	33.0
% Permanent residents	--	--	24.3	56.9
% Temporary residents	--	--	8.4	10.1
Degree Level				
% Bachelor's as the highest degree	72.9	73.8	28.1	64.2
% Master's as the highest degree	25.3	21.4	67.4	32.1
% Doctorate as the highest degree	1.8	4.8	4.5	3.7
Employment Sector				
% Educational institutions	11.7	9.5	6.9	3.7
% For-profit firms	68.4	59.5	82.6	83.5
% Self-employment	1.3	7.1	1.2	1.8
% Non-profit organizations	6.0	11.9	2.7	1.8
% Federal government	5.7	4.8	1.5	2.8
% State/local government	6.9	7.1	5.1	6.4
Mean years since the highest degree	15.7	14.5	10.6	13.6
% Supervisor	34.6	21.4	21.6	18.4
Primary work activities				
% Research and development	15.4	23.8	15.6	12.8
% Teaching	3.3	--	1.2	--
% Management and administration	24.9	19.1	12.6	8.3
% Computer application	52.3	50.0	68.0	74.3
% Other work activities	4.2	7.1	2.7	4.6
Employer Region				
% New England	8.4	4.8	3.3	5.5
% Middle Atlantic	15.3	11.9	15.9	19.3
% East North Central	15.6	4.8	12.3	12.8
% West North Central	9.1	2.4	3.9	3.7
% South Atlantic	20.3	9.5	15.9	14.7
% East South Central	3.5	--	0.6	5.5
% West South Central	8.9	2.4	12.0	6.4
% Mountain	6.1	--	1.5	1.8
% Pacific	12.9	64.3	34.7	30.3
Nationality of Asian-born computer scientists				
% Chinese *			45.2	14.7
% Indian			15.6	62.4
% Taiwanese			18.6	2.8
% Japanese			0.6	0.9
% Korean **			3.9	--
% Filipino			3.6	16.5
% Vietnamese			8.1	0.9
% Others			4.4	1.8

Note: The percentages of some categories, such as degree level, do not add up to 100 due to rounding.
Source: National Survey of College Graduates, 2003
* Including Hong Kong and Macao; ** Including Korean (not specified) and South Korean

Similarly for Asian-born computer scientists and engineers with few exceptions, in both years, for both males and females, the largest three nationality groups among U.S.-educated immigrants were the Chinese, Indians, and the Taiwanese (not in the actual numeric order in all cases). Among Asian-educated immigrants, they were Indians, Filipinos, and the Chinese. The demographic characteristics of these computer scientists and engineers, including the differences in educational attainment between native-born and foreign-born engineers, especially U.S.-educated immigrants, as well as employment or residential concentration, are mostly consistent with the characteristics of native-born and foreign-born information technology (IT) workers in general in the U.S. In general, compared with their native-born counterparts, foreign-born (including naturalized U.S. citizens, permanent residents, and people on temporary visas) IT workers are more likely to be Asians or Hispanics than whites or African Americans. The foreign-born in the IT workforce tend to be more highly educated than their native-born counterparts. They concentrate in just a few states, including California (in the Pacific region), New York and New Jersey (in the Middle Atlantic region), and Illinois (in the East North Central region). The native-born, however, are concentrated in California, Texas (in the West South Central region), and New York (Ellis and Lowell 1999; Lowell 2004).

5.3 Salaries of White and Asian Engineers

In 1993, the mean salary of engineers was $54,580 (or $69,500 in 2003 currency).[7] More specifically, it was higher for men ($55,178 in 1993 or $70,261 in 2003 currency) than for women ($47,126 in 1993 or $60,008 in 2003 currency) (Figure 5.1, 4th columns). To match the 2003 data, I converted the 1993 earnings into 2003 dollar value. Further disaggregating data by the level of degree, I find that at the bachelor's, master's, and doctoral levels, the mean salaries for male engineers were $67,178; $75,273; and $86,864; respectively, in 2003 dollar values (Figure 5.1), which were more than women at each level. In 2003, male engineers earned $77,033; $84,563; and $94,707 at the bachelor's, the master's, and the doctoral levels, respectively. Again, they earned more than women at each level (Figure 5.2).

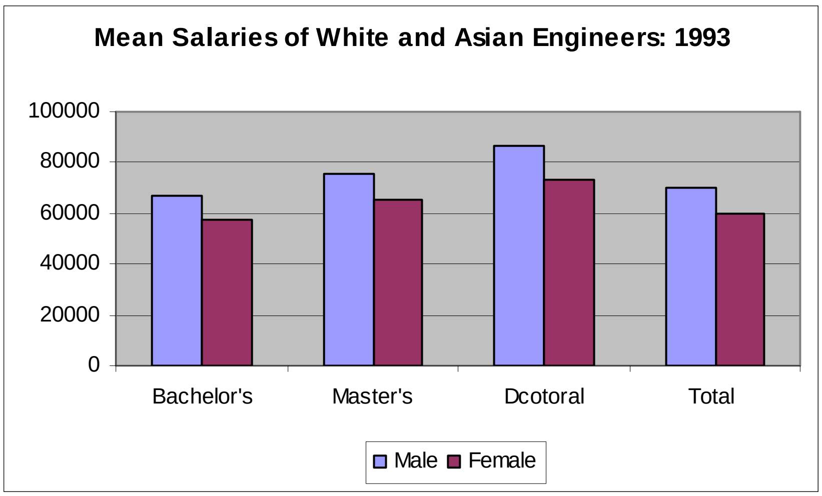

Figure 5.1

To better understand the earning differences of Asians and whites at different degree levels, I separate men from women in the following analysis. In 1993, among male engineers, Asians (born in the U.S. or in Asia) had lower earnings than whites on average and at all degree levels (Figure 5.3). In 2003, Asians still earned less than whites at the master's and the doctoral levels, but they earned more at the bachelor's level (Figure 5.4).

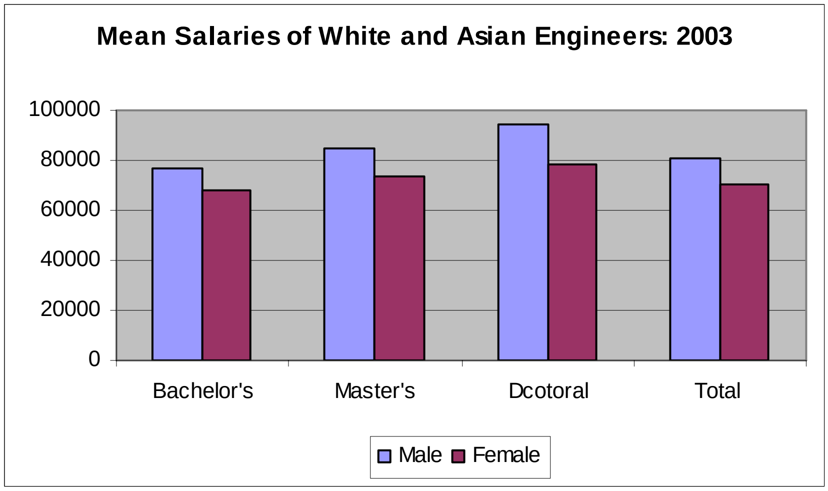

Figure 5.2

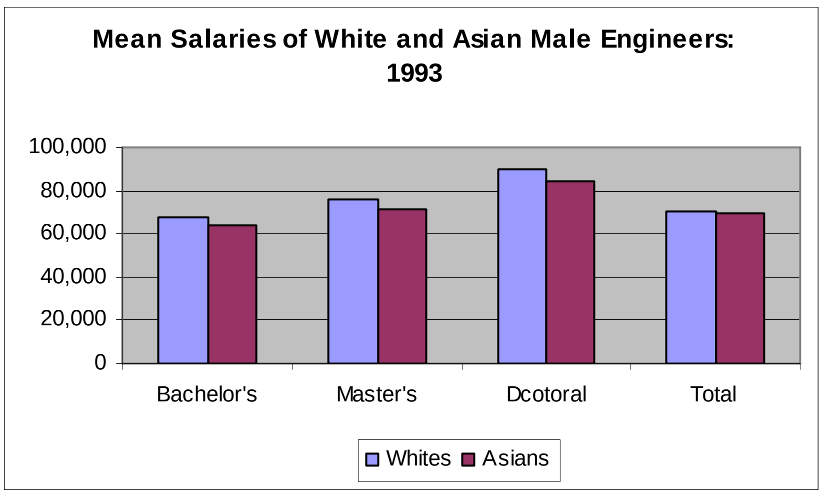

Figure 5.3

When nativity is considered, I find that in 1993, on average, whites, Asian Americans, and Asian immigrants had similar earnings (Figure 5.5). At the bachelor's and master's degree levels, whites earned similarly to Asian Americans, who earned more than Asian immigrants. At the doctoral level, the number for Asian Americans was too small to be analyzed (N=1 in 1993), but whites earned more than Asian immigrants. In 2003, while Asian Americans earned more than whites at the bachelor's and doctoral levels, Asian immigrants still earned less than Asian Americans and whites at all levels (Figure 5.6). Then, the earning disadvantages of Asian men seemed to be mainly explained by Asian male immigrants rather than both immigrants and Asian Americans.

Figure 5.4

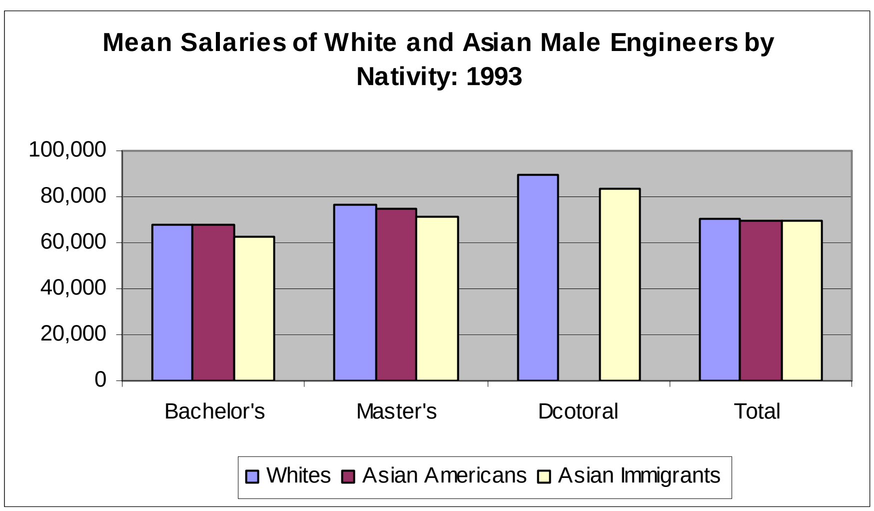

Figure 5.5

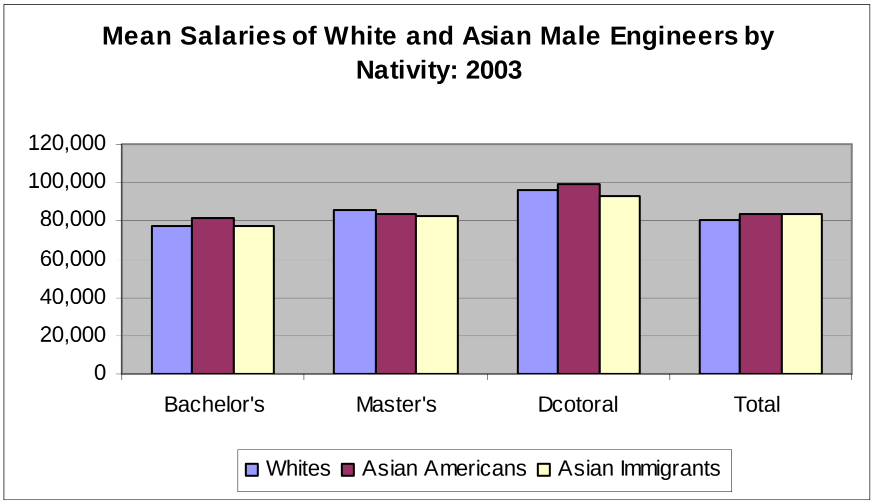

Figure 5.6

Further disaggregating data results in the groups of U.S.- and Asian-educated Asian immigrants who received their highest degrees in the U.S. and Asia, respectively. Results show that in 1993, both U.S.- and Asian-educated male immigrants earned lower salaries than whites and Asian Americans at all degree levels (Figure 5.7). While U.S.- and Asian-educated immigrants earned similarly at the bachelor's level, those who received highest degrees in Asia earned the least at both the master's and the doctoral levels. The mean salary of U.S.-born Asian engineers at the doctoral level is not shown in the graph due to the small number of this group (N=1).

In 2003, while Asian Americans earned less than whites only at the master's level, U.S.-educated immigrants earned less than Asian Americans at both the master's and the doctoral levels. Asian-educated immigrant engineers earned the least across the degree level (Figure 5.8). Thus, in both 1993 and 2003, Asian male engineers' earning disadvantages could be accounted for by Asian-educated and, to a lesser degree, U.S.-educated immigrants.

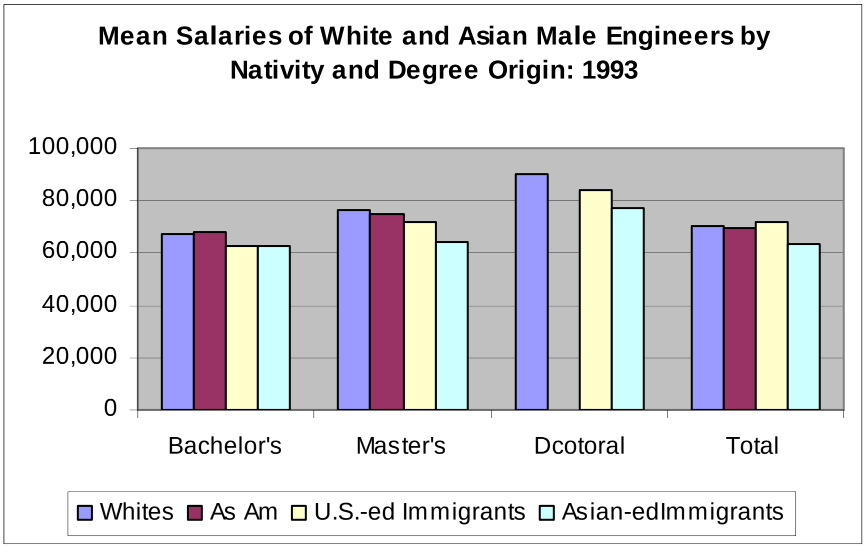

Figure 5.7

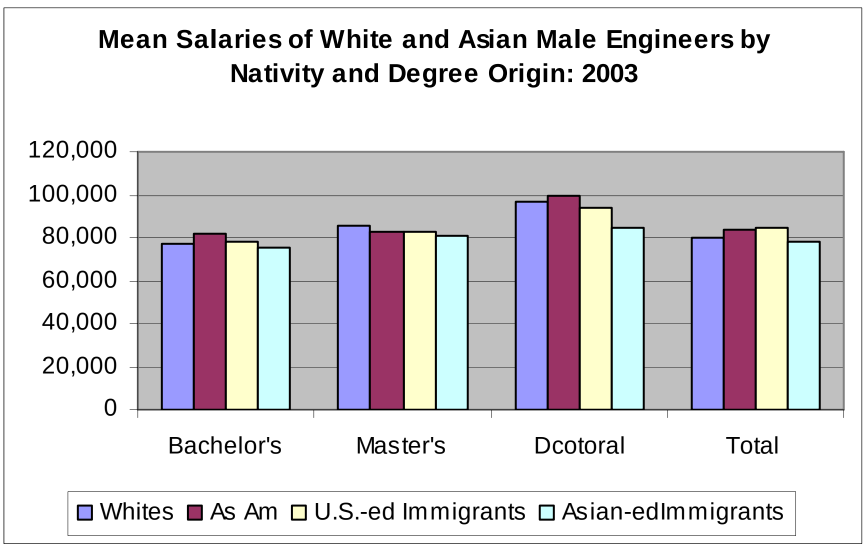

Figure 5.8

Among female engineers, the patterns were different. Asians (born in the U.S. or in Asia), in both years, earned more than U.S.-born whites except at the master's level in 1993 (Figure 5.9). Asians' advantages were especially clear at all degree levels in 2003 (Figure 5.10).

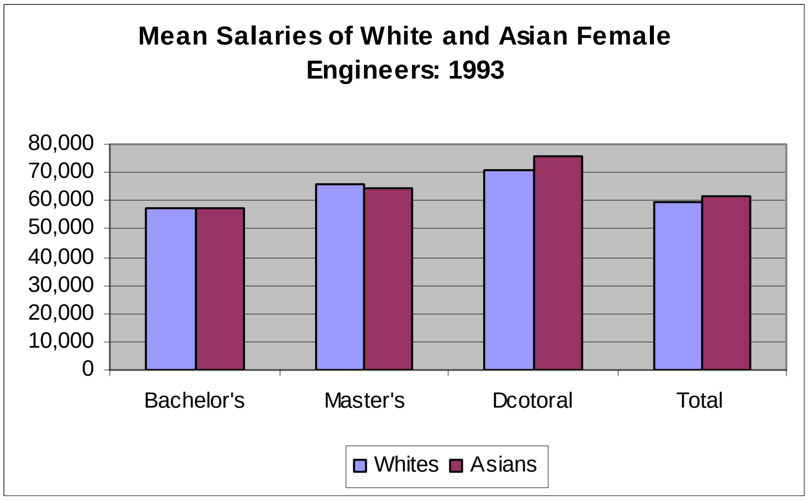

Figure 5.9

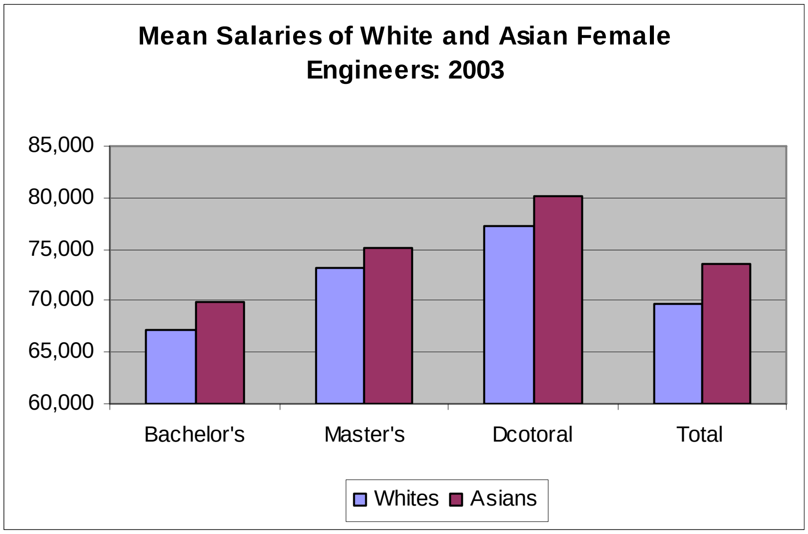

Figure 5.10

Disaggregating Asians by nativity shows that in 1993, while Asian immigrants earned the most at the doctoral level but the least at the bachelor's and the master's levels. Asian Americans earned more than other groups at the bachelor's and the master's (Figure 5.11). The mean salary of doctoral Asian American engineers is not shown in the graph due to the small number (N=1). In 2003, Asian American women engineers earned the highest salaries at the bachelor's and the doctoral levels. The mean salary of Asian immigrants exceeded that of whites as a whole and at all degree levels and earned the most at the master's level (Figure 5.12).

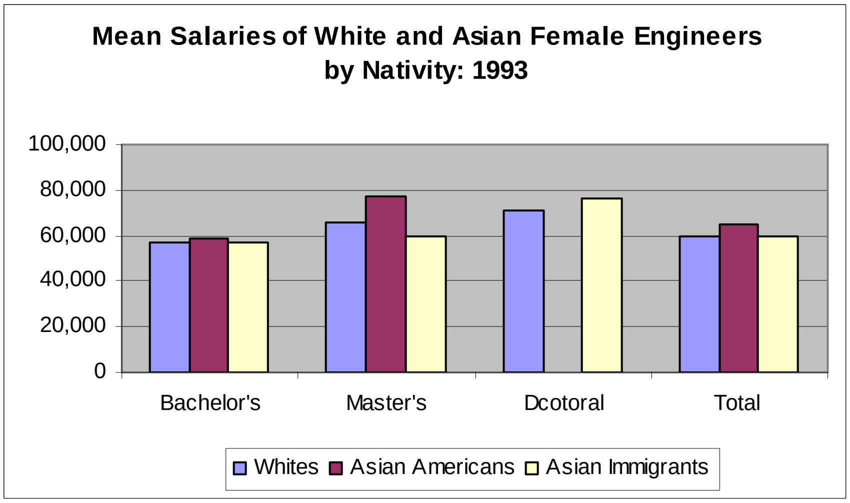

Figure 5.11

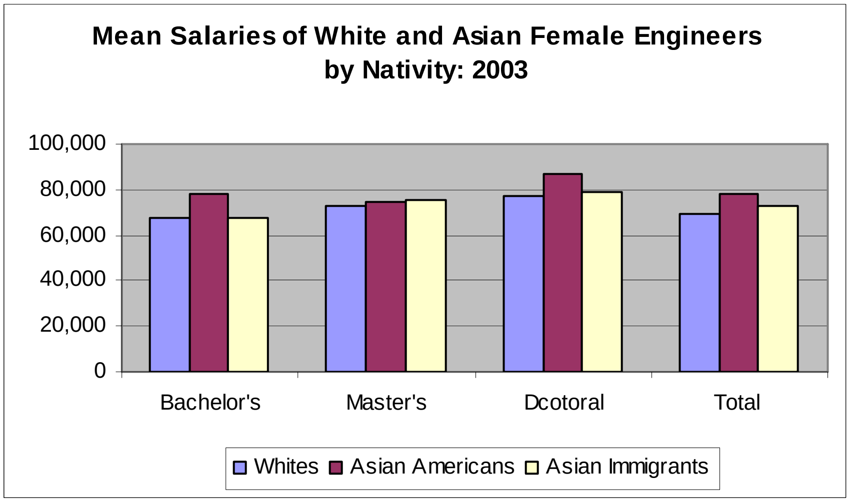

Figure 5.12

Further disaggregating data of women engineers reveals that in 1993, U.S.-educated immigrant engineers earned less than Asian Americans, and Asian-trained immigrant engineers earned less than the U.S.-educated and other groups except at the master's level (Figure 5.13). In 2003, Asian-educated immigrants still earned less than other groups except at the master's level, at which they earned the highest salary (Figure 5.14).

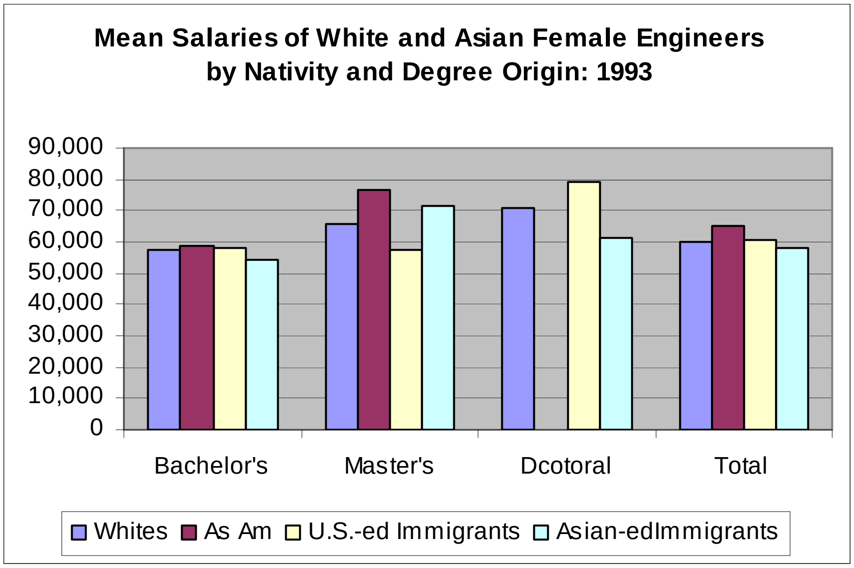

Figure 5.13

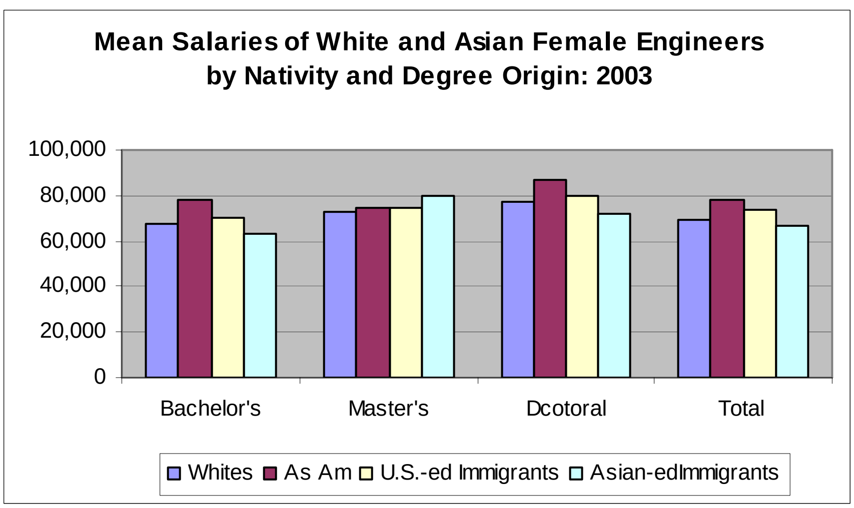

Figure 5.14

The pictures of women's were less consistent than those of their male counterparts. However, overall, Asian women engineers' earning advantage over whites is mainly explained by those of Asian Americans and to a lesser degree, U.S.-educated immigrants, at the bachelor’s and the doctoral levels but by Asian Americans and Asian-educated immigrants at the master’s level.

The above analysis shows that Asian engineers are not the same. When comparing white and all Asian males, I find fairly consistent patterns in 1993 and 2003 for each gender. Changes appear when I consider nativity. Although Asian Americans did not earn consistently less than whites, Asian immigrants earned less than the other two groups at each level in both years except at the bachelor’s level in 2003. When Asians are further disaggregated, I find that it is Asian-educated immigrants who were the most disadvantaged or earned the least in most cases, which did not change over time.

Among female engineers, Asians as a group clearly earned more than whites in most cases. When nativity is introduced, in some cases, Asian Americans, and in others, Asian immigrants, explained Asians’ earning advantages over whites. Further disaggregated data show that no single group could explain all Asians’ earning advantages in 1993 and 2003. Nevertheless, Asian-educated immigrants tended to earn the least.

I may tentatively conclude that Asian engineers of different nativity and degree origin presented different patterns when compared with whites. Recall that the difference between Asian Americans and whites could indicate the net effect of race; that between U.S.-educated immigrants and Asian Americans, nativity; and that between Asian- and U.S.-educated immigrants, degree origin. With some exceptions, Asian Americans tended to earn similarly to or more than whites at the same degree level, showing no or a possible positive effect of the Asian race. U.S.-educated immigrants tended to earn less than Asian Americans at the same degree level, showing a possible net effect of Asian nativity. Both male and female Asian-educated immigrants tended to earn less than U.S.-educated immigrants at the same degree level, although the disadvantages were more consistent for males than for females. This indicates a possible negative effect of the highest degree from an Asian institution. The findings also show gender differences. In addition to that men earned more than women at each degree level in each year in either field, men and women also differed in earning differences between whites and Asians (all categories). At the most aggregated level, Asian women fared better than Asian men when both are compared with their white peers.

5.4 Salaries of White and Asian Computer Scientists

Compared with engineers, computer scientists presented similar patterns in some aspects and different patterns in others. Among males, while Asian engineers earned less than whites in all cases except at the bachelor's level in 2003, Asian male computer scientists earned more or slightly more than whites at the doctoral level in 1993 and at all levels in 2003 (Figures 5.15 and 5.16).

When nativity is introduced, in 1993, Asian Americans earned less than whites but similarly to Asian immigrants at the bachelor's level. They earned more than both whites and Asian immigrants at the master's level (Figure 5.17). The mean salaries of doctoral Asian Americans is not shown in the graph because of its small number (N=1). In 2003, Asian Americans earned the least at the bachelor's level but most at other levels (Figure 5.18).

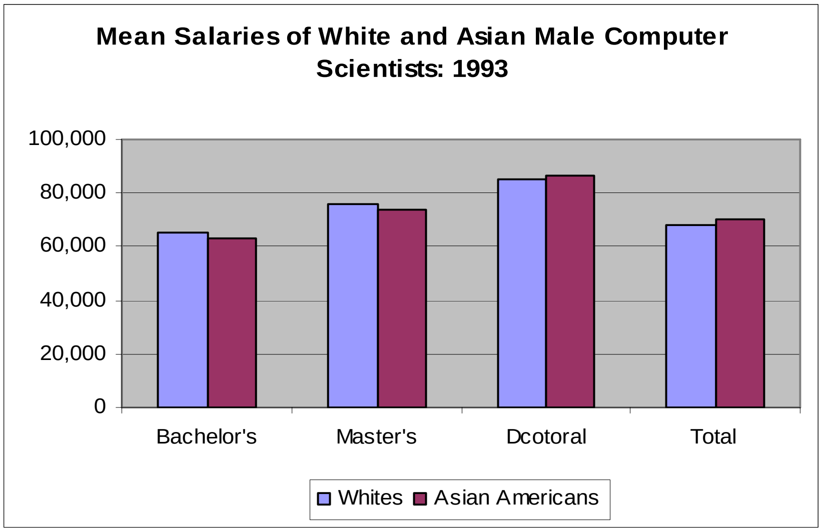

Figure 5.15

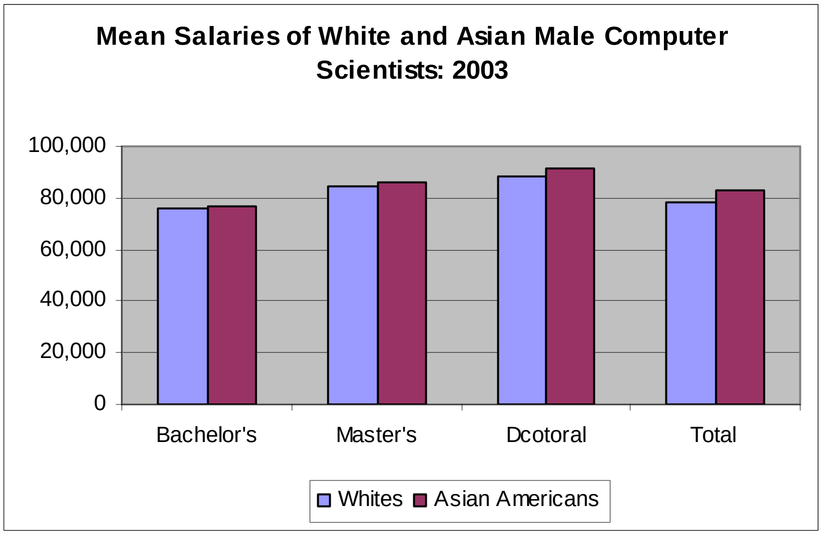

Figure 5.16

When Asian immigrants are disaggregated, the pictures become more complex. Asian Americans earned similarly to or slightly less than other groups at the bachelor's level but the most at the master's level in both years. U.S.-educated immigrants earned less than Asian immigrants at the master's level in 1993 and at the master's and the doctoral levels in 2003. Asian-educated computer scientists earned similarly to or less than other groups in all cases except at the bachelor's level in 2003, when they earned the most (Figures 5.19 and 5.20).

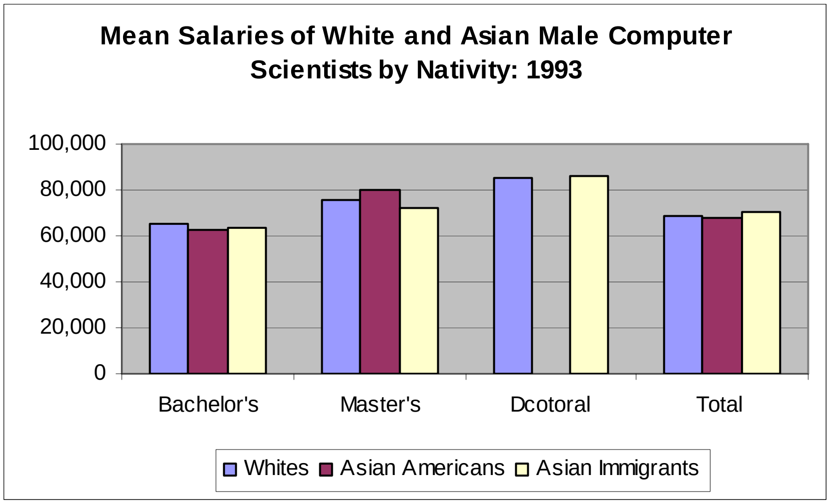

Figure 5.17

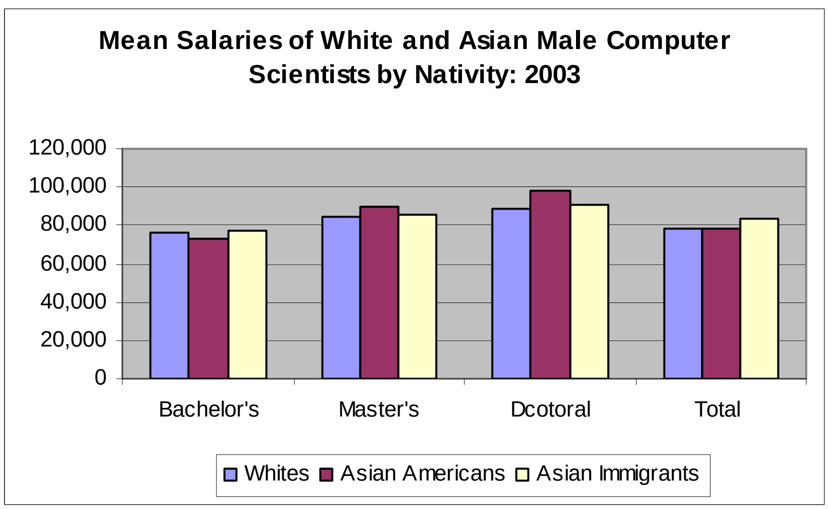

Figure 5.18

Among female computer scientists, the pictures in 1993 and 2003 were similar to those of female engineers (Figures 5.21 and 5.22). When Asian women are disaggregated, due to the lack of data on Asian American female computer scientists in the 1993 sample, Asians' earning advantage at the doctoral level in 1993 was attributed to Asian immigrants (Figure 5.23). In 2003, not any female group earned the most at all levels, but Asian-educated immigrants earned slightly more than other groups at the master level but less at bachelor's and doctoral levels (Figure 5.24). Asian American female computer scientists were similar to their engineer counterparts only at the doctoral level. At both the master's and doctoral levels, Asian Americans earned the most.

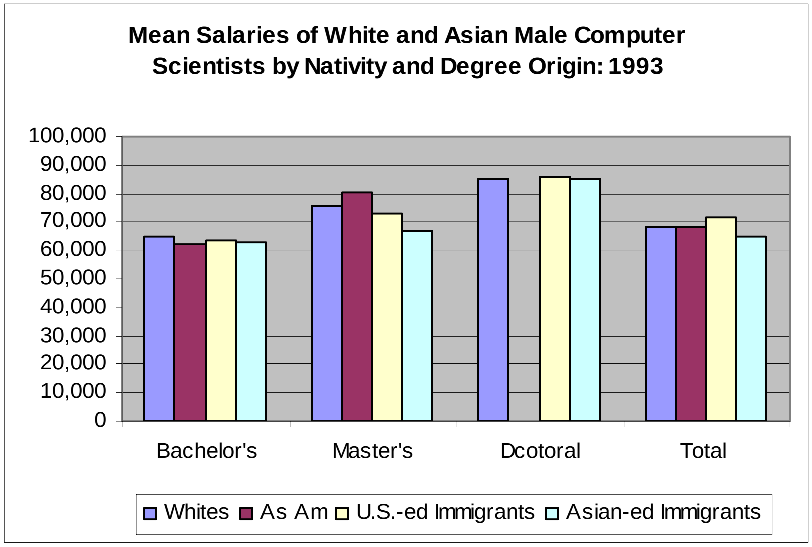

Figure 5.19

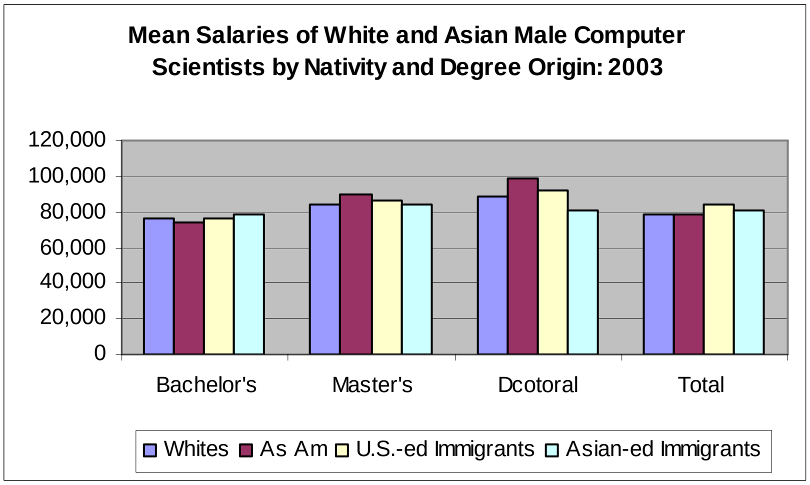

Figure 5.20

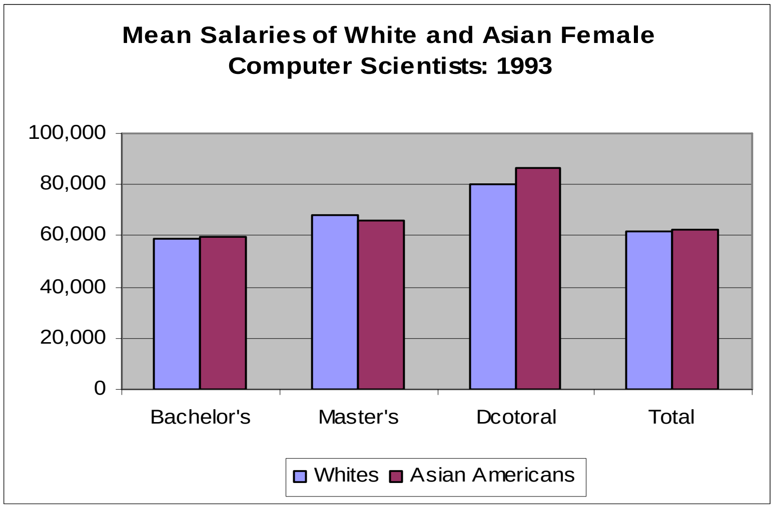

Figure 5.21

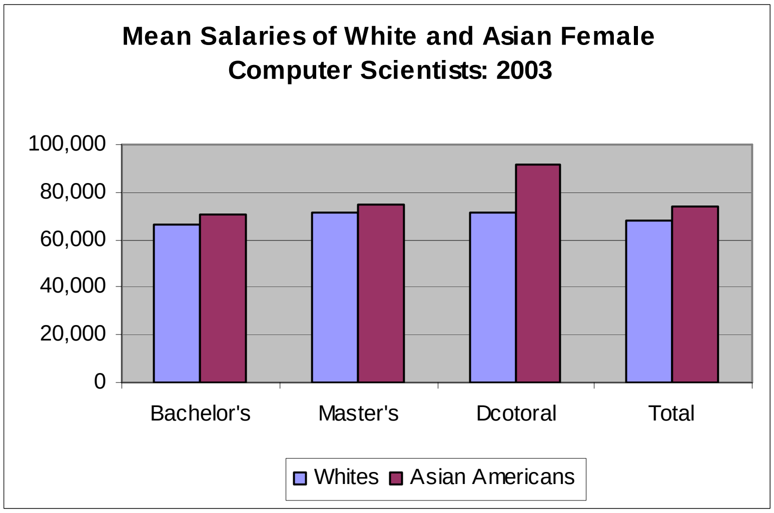

Figure 5.22

Further disaggregated data for women were not available for Asian-educated immigrants at the doctoral levels because of the small numbers (N=1) in 1993. However, one consistent pattern is that Asian-educated immigrants earned the least at the bachelor's and the master's levels in 1993 (Figure 5.25). In 2003, Asian Americans and U.S.-educated immigrants earned the most at the master's and the doctoral levels, respectively. Asian-educated immigrants earned the most at the bachelor's level (Figure 5.26).

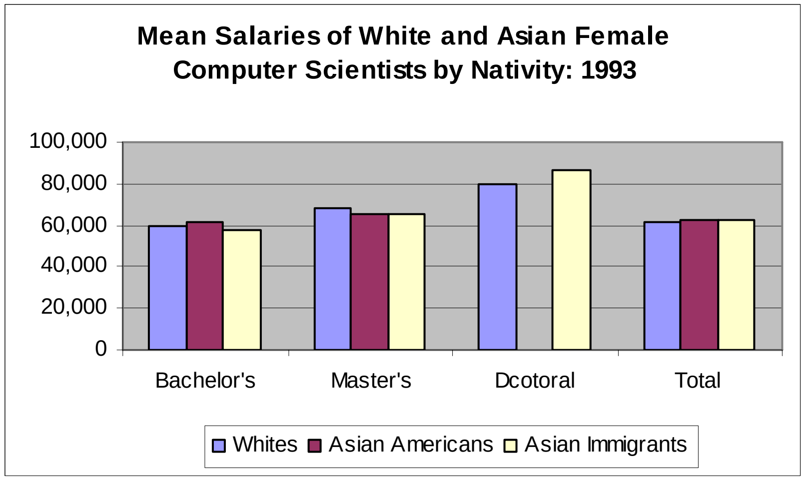

Figure 5.23

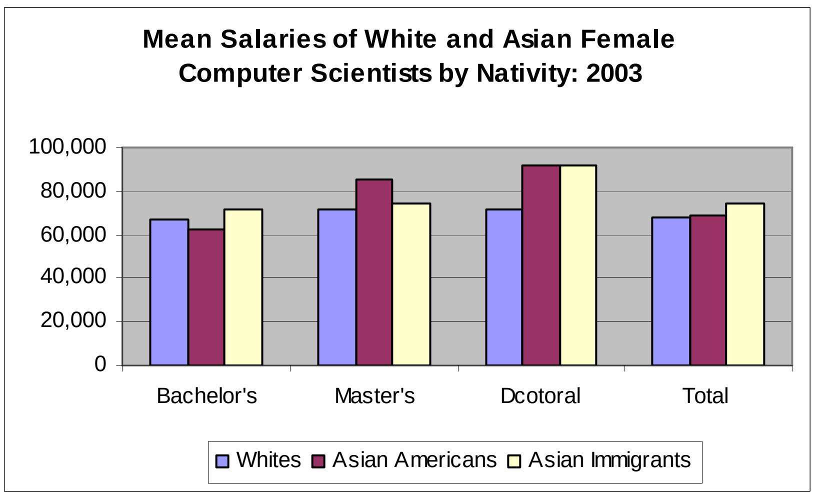

Figure 5.24

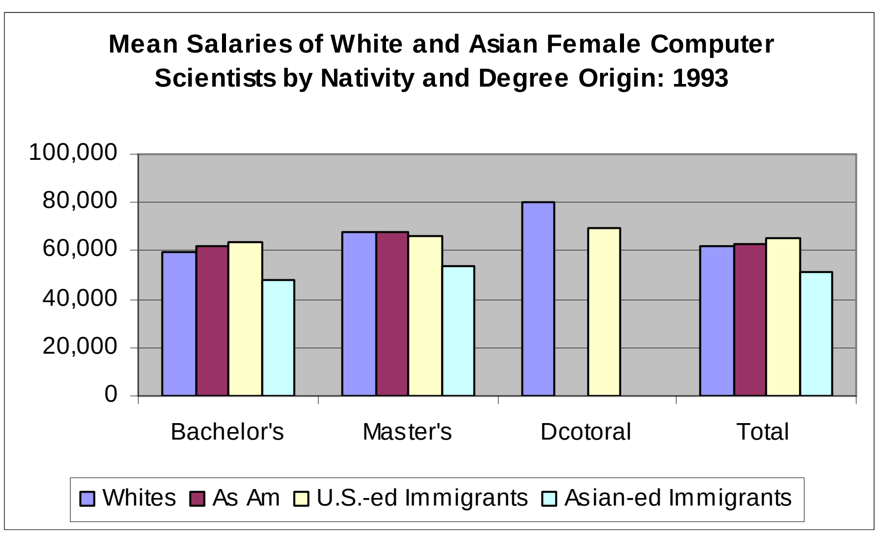

Figure 5.25

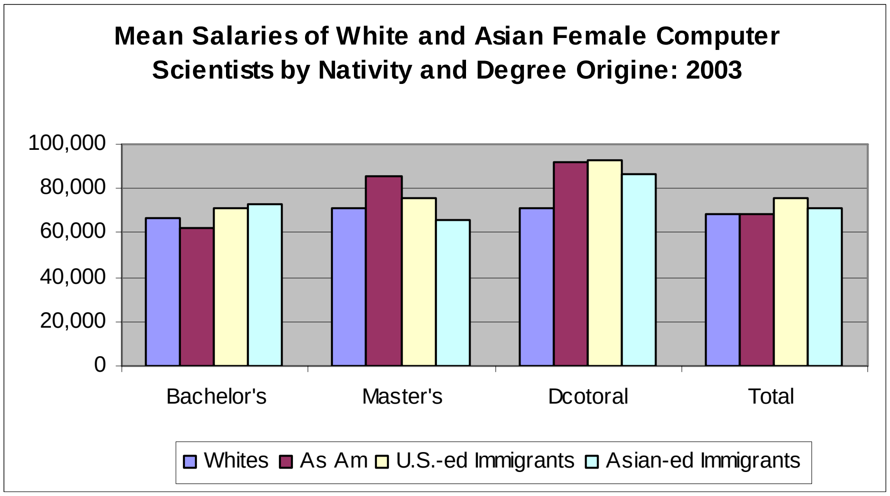

Figure 5.26

Among computer scientists, in 1993, Asian-educated male and female computer scientists tended to earn less than other groups. In 2003, at the master's and the doctoral levels, they tended to earn less than other groups (but not necessarily the least in all cases), but at the bachelor's level, both men and women earned the most. Thus, compared with engineers, the disadvantages of Asian-educated immigrants in computer science were similar but less consistent. In both fields, U.S.-educated immigrants tended to earn more than the Asian-educated among both men and women. Asian Americans had less clear and consistent patterns across gender and field and over years. Compared with other groups, they were advantaged in some cases but disadvantaged in others. Again, across field and degree levels, males' patterns seemed to be more consistent than those of females'.

In short, the above analyses show that although the patterns were not the same in all cases, they seem to point to a certain direction. Among males, across field and degree levels, the order from earning the most to the least tended to be Asian Americans, whites, U.S.-educated Asian immigrants, and Asian-educated Asian immigrants. However, among women, the patterns were less clear-cut. One trend was that with exceptions, Asian Americans earned more than whites and U.S.-educated immigrants, and the Asian-educated earned the least. They seem to indicate an earning advantage of Asian race (the difference between Asian Americans and whites), an earning disadvantage of Asian nativity (the difference between U.S.-educated immigrants and Asian Americans), and an earning disadvantage of Asian degree (the difference between Asian- and U.S.-educated immigrants). Yet, the above analyses do not control for factors other than year, field, gender, and the level of degree, they blanket the influences of many other factors, such as age, marital status, and the employment region. A better understanding whether the advantages of some groups and the disadvantages of others, specifically Asian-educated immigrants, are statistically significant needs multivariate regressions.

CHAPTER 6

REGRESSION RESULTS

This chapter employs quantile regressions to determine the effects of some factors on the earnings of Asian computer scientists and engineers. First, I examine the effects of race, nativity, and degree origin (or the origin of the highest degree) on earnings. Next, I examine whether these effects exist across gender, field, and employment sector. Then, I investigate differences in earnings due to gender, field, and employment sector as well as national origin. For all these effects and differences, I examine their changes from 1993 to 2003). I use .90 and .50 quantile points to examine the distribution of earnings due to the above effects.

All quantile regressions used and reported in this dissertation control for relevant variables. When I report findings, unless noted otherwise, these results are statistically significant. For instance, when I report that one group earns more or less than the other, I mean that the difference between these groups is statistically significant (or simplified as significant). Similarly, if some effects are not significant or do not exist, that means these effects are not statistically significant.

6.1 The Effects of Race, Nativity, and Degree Origin

6.1.1. Total Effects

Regression results show the effects of independent variables after controlling for personal, educational, and employment characteristics. At the 90th quantile, whites earned significantly more than their U.S.-educated immigrant counterparts. The differences between U.S.-educated immigrants and Asian Americans and between U.S.- and Asian-educated immigrants were not statistically significant (Table 6.1).

Table 6.1. Estimated Quantile Regression Coefficients from Earning Estimations for Computer Scientists and Engineers (90th quantile; Reference: U.S.-educated Immigrants)

White	0.0236**
	(0.0087)
Asian American	0.00391
	(0.016)
Asian-educated Immigrants	-0.00873
	(0.013)
Male	0.0508***
	(0.011)
Age	0.0241***
	(0.0027)
Age-squared	-0.000235***
	(0.000031)
Married	0.0288*
	(0.013)
Having children	0.00147
	(0.012)
Male*married	0.0153
	(0.015)
Male*Having children	0.00747
	(0.013)
Citizenship Status (Reference: U.S. citizens)	
Permanent residents	0.00944
	(0.013)
Temporary residents	-0.00421
	(0.019)
The Type of the Highest Degree (Reference: the Bachelor's)	
Master's	0.133***
	(0.0055)
Doctoral	0.255***
	(0.012)
The Field of the Highest Degree (Reference: Engineering)	
Computer and related sciences	0.0285***
	(0.0081)
Physical and related sciences	-0.0260*
	(0.012)
Biological and related sciences	-0.132***
	(0.018)
Social and related sciences	-0.0313*
	(0.015)
Other fields	-0.0486***
	(0.0066)

(Table 6.1 Continued)

The Employment Sector (Reference: Educational institutions)	
Self-employment	0.591***
	(0.020)
For-profit firms	0.181***
	(0.012)
Non-profit organizations	0.107***
	(0.020)
Federal government	0.0898***
	(0.015)
State/local government	-0.0498**
	(0.016)
Work experience	0.0150***
	(0.0012)
Work experience-squared	-0.000165***
	(0.000030)
Supervisor	0.0939***
	(0.0047)
Primary Work Activity (Reference: Management and administration)	
Teaching	-0.108***
	(0.021)
R&D	-0.0335***
	(0.0063)
Computer application	-0.0671***
	(0.0073)
Other work activity	-0.0640***
	(0.0087)
The Employment Location (Reference: New England)	
Middle Atlantic	-0.0193
	(0.010)
East North Central	-0.0952***
	(0.010)
West North Central	-0.135***
	(0.012)
South Atlantic	-0.0234*
	(0.010)
East South Central	-0.105***
	(0.014)
West South Central	-0.0245*
	(0.011)
Mountain	-0.0415***
	(0.012)
Pacific	0.0645***
	(0.0100)
Computer scientist (vs. engineer)	0.0527***
	(0.0072)
Year 2003	0.137***
	(0.0048)
Constant	10.36***
	(0.057)
Observations	31947
Pseudo R-squared	0.1995

Notes: standard errors in parentheses; * coefficient statistically significant at 0.05 level ($p<0.05$); ** coefficient statistically significant at 0.01 level ($p<0.01$); *** coefficient statistically significant at 0.001 level ($p<0.001$)

I have conducted regressions at the .50 quantile level as well. However, I do not list the tables at the .50 quantile level but discuss them in the text in this study. Compared with their U.S.-educated immigrant counterparts, whites and Asian Americans earned significantly more and Asian-educated immigrants earned less.

For a clearer presentation of the effects of race, nativity, and degree origin, I translate Table 6.1 into Table 6.2. As discussed in Chapter 4 (Methodology), the difference between comparable whites and Asian Americans indicates the net effect of race, that between comparable Asian Americans and U.S.-educated Asian immigrants shows the net effect of nativity, and the difference between comparable U.S.- and Asian educated immigrants suggests the net effect of the degree origin.

Pair-wise comparison results show that the earning differences between whites and Asian Americans and between Asian Americans and U.S.-educated immigrants are not statistically significant, but that between U.S.- and Asian-educated immigrants is. This means that at the .90 point, Asian race, nativity, or degree origin does not have statistically significant effects on the salaries of Asian computer scientists and engineers (Table 6.2). At the .50 point, however, while Asian race does not have an effect, both Asian nativity and degree origin have statistically significant, negative effects on earnings. Asian nativity leads to a 2.9% earning disadvantage, and Asian highest degree, a 4.1% earning disadvantage.[8]

Table 6.2. The Net Effects of Race, Nativity, and Degree Origin (Total Effects) (90th quantile)

Asian Race	-.0197
	(0.014)
Asian Nativity	-.00391
	(0.016)
Asian Degree Origin	-.00873
	(0.013)

Notes: 1. The above results are the pairwise t-test results following the multivariate regression that is reported in Table 6.1. As discussed in the methodology chapter, difference between comparable Asian Americans and whites indicates the net effect of race, which is reflected in the variable "Asian Race" (Asian=1; white=0) in this table. Similarly, the coefficient of "Asian Nativity" is the difference between the coefficients of U.S.-educated Immigrants and Asian Americans, and that of "Asian Degree Origin" is the difference between the coefficients of Asian- and U.S.-educated immigrants.

In the following tables that show the net effects of race, nativity, and degree origin, I use the same way to present the earning differences of two groups.

2. Standard error in parentheses
3. * coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)

6.1.2 Change over Time

The above results show us the general effects of race, nativity, and degree origin. To understand the changes in these effects, I should analyze data in both 1993 and 2003. In 1993, at the 90% quantile point, whites earned more and Asian-educated immigrants earned less than U.S.-educated immigrants (Table 6.3). In 2003, compared with U.S.-educated immigrants, no group earned more or less (Table 6.3). At the 50th quantile, in 1993, both whites and Asian Americans earned more but Asian-educated immigrants earned less than U.S.-educated immigrants. In 2003, no group earned statistically significant from the U.S.-educated immigrants.

Table 6.3. Estimated Quantile Regression Coefficients from Earning Estimations, 1993 and 2003 (90th quantile; Reference: U.S.-educated Immigrants)

	1993	**2003**
White	0.0362**	0.00317
	(0.012)	(0.010)
Asian American	0.0128	0.00988
	(0.021)	(0.021)
Asian-educated Immigrants	-0.0973***	0.00513
	(0.020)	(0.015)
Male	0.0319*	0.0776***
	(0.015)	(0.015)
Age	0.0294***	0.0193***
	(0.0035)	(0.0036)
Age-squared	-0.000281***	-0.000206***
	(0.000040)	(0.000041)
Married	0.0387*	0.0374*
	(0.017)	(0.016)
Having children	-0.0202	0.0203
	(0.017)	(0.015)
Male*Married	-0.00186	0.0199
	(0.019)	(0.019)
Male*Having children	0.0248	-0.0141
	(0.018)	(0.017)
Citizenship Status (Reference: U.S. citizens)		
Permanent residents	-0.00342	-0.0182
	(0.019)	(0.015)
Temporary residents	0.131***	-0.0739***
	(0.038)	(0.020)
The Type of the Highest Degree (Reference: the Bachelor's)		
Master's	0.144***	0.114***
	(0.0071)	(0.0073)
Doctoral	0.312***	0.219***
	(0.017)	(0.014)
The Field of the Highest Degree (Reference: Engineering)		
Computer and related sciences	0.00944	0.0395***
	(0.011)	(0.010)
Physical and related sciences	-0.0378*	-0.0238
	(0.016)	(0.017)
Biological and related sciences	-0.121***	-0.142***
	(0.024)	(0.022)
Social and related sciences	-0.0359	-0.0234
	(0.019)	(0.019)
Other fields	-0.0640***	-0.0272**
	(0.0083)	(0.0092)
The Employment Sector (Reference: Educational institutions)		
Self-employment	0.690***	0.373***
	(0.028)	(0.024)
For-profit firms	0.164***	0.204***
	(0.018)	(0.015)

(Table 6.3 Continued)

Non-profit organizations	0.0991***	0.127***
	(0.028)	(0.024)
Federal government	0.0655**	0.130***
	(0.020)	(0.019)
State/local government	-0.0476*	-0.0584**
	(0.022)	(0.019)
Work experience	0.0164***	0.0135***
	(0.0015)	(0.0016)
Work experience-squared	-0.000184***	-0.000139***
	(0.000037)	(0.000041)
Supervisor	0.0859***	0.116***
	(0.0060)	(0.0062)
Primary Work Activity (Reference: Management and administration)		
Teaching	-0.0969***	-0.0734**
	(0.028)	(0.026)
R&D	-0.0377***	-0.0230**
	(0.0084)	(0.0081)
Computer application	-0.0648***	-0.0591***
	(0.0098)	(0.0090)
Other work activity	-0.0622***	-0.0605***
	(0.011)	(0.012)
The Employment Location (Reference: New England)		
Middle Atlantic	0.000943	-0.0182
	(0.013)	(0.014)
East North Central	-0.0776***	-0.0989***
	(0.013)	(0.013)
West North Central	-0.106***	-0.153***
	(0.016)	(0.016)
South Atlantic	-0.0191	-0.0141
	(0.013)	(0.013)
East South Central	-0.0761***	-0.106***
	(0.018)	(0.019)
West South Central	-0.00329	-0.0271
	(0.014)	(0.015)
Mountain	-0.0508**	-0.0144
	(0.016)	(0.016)
Pacific	0.0633***	0.0840***
	(0.013)	(0.013)
Computer scientist (vs. engineer)	0.0508***	0.0526***
	(0.0095)	(0.0093)
Constant	10.23***	10.61***
	(0.074)	(0.074)
Observations	17724	14223
Pseudo R-squared	0.21	0.16

Notes: Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

Pair-wise comparison results show that in 1993, at the .90 point, Asian race and nativity did not significantly influence the earnings. However, the Asian highest degree had a statistically significant, negative effect. Asian-educated immigrants earned 90.7% (exp(-.0973)=.907; same for the following percentages) as much as their U.S.-educated counterparts. Nevertheless, these negative effects disappeared in 2003 (Table 6.4). At the .50 point, in 1993, both Asian nativity and Asian degree origin had negative effects—3.5% and 11.5% of earning disadvantages, respectively. Please note that the effects of race, nativity, and degree origin are net effects. That is to say, Asian-educated immigrants suffered from not only degree origin effect but also nativity effect in earnings when compared with their white counterparts. In 2003, similar to the results at the .90 point, none of the three factors had a significant effect on earnings. In the following discussions of the effects of race, nativity, and degree origin, I will list in the tables the three effects only but not control variables (as listed in Tables 6.1 and 6.3).

Table 6.4. The Estimated Net Effects of Asian Race, Nativity, and Degree Origin, 1993 and 2003 (90th quantile)

	1993	**2003**
Asian Race	-.0234	.00671
	(0.019)	(0.019)
Asian Nativity	-.0128	-.00988
	(0.021)	(0.021)
Asian Degree Origin	-.0973***	.00513
	(0.020)	(0.015)

Notes: Standard errors in parentheses
* coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)

Thus, Hypothesis 1a (in Chapter 3), which hypothesizes that race and nativity have less strong effects on Asian computer scientists and engineers' earnings than the origin of the highest degree, is supported. Hypothesis 1b, *i.e.,* the effect of the origin of the highest degree narrows from 1993 to 2003, is also supported. In fact, the effect of the origin of the highest degree disappeared in 2003 at both quantile points.

6.2 The Role of Gender

This section disaggregates data by gender to see whether and how the effects of race, nativity, and degree origin on earnings and their changes over time are different for men and women. In addition, this section examines gender differences in earnings by race, or across the four groups, whites, Asian Americans, U.S.-educated immigrants, and Asian-educated immigrants. Furthermore, this section investigates the effect of the "double bind" for Asian women of each category.

6.2.1. Race, Nativity, and Degree Origin Effects for Men and Women

After controlling for personal, educational, and employment characteristics as well as the year, I find that among men, at the 90th quantile, neither of the three factors, race, nativity, or degree origin has an effect. Disaggregating data for men by year reveals that in 1993, both Asian race and degree origin had negative effects, but they disappeared in 2003 (Table 6.5). At the .50 point, in 1993, both Asian nativity and degree origin had negative effects, but in 2003, their effects also disappeared.

Among women, at the .90 point level, in 1993, Asian degree origin led to an earning disadvantage, or in other words, Asian-educated immigrants earned less than their U.S.-educated counterparts. But this negative effect existed in only 1993 but not 2003 (Table 6.6). At the .50 level, similar to the finding at the .90 level, in 1993, Asian degree origin also had a negative effect, which also disappeared in 2003.

Table 6.5. The Estimated Net Effects of Race, Nativity, and Degree Origin for Men, 1993, and 2003 (90th quantile)

	Total	1993	2003
Asian Race	-.0239	-.0399*	.0133
	(0.018)	(0.019)	(0.024)
Asian Nativity	-.0009	.00256	-.0150
	(0.020)	(0.022)	(0.026)
Asian Degree Origin	-.0184	-.0995***	-.00415
	(0.016)	(0.020)	(0.018)
Observations	26,874	15,193	11,681
Pseudo R-squared	0.20	0.21	0.15

Notes: 1. All control variables listed in Tables 6.1 (for the Total model) and 6.3 (for the 1993 and 2003 models) are used in regressions but not reported in this table. The only difference in the control variables in the Total model and the 1993 and 2003 models is that the former includes a dummy year variable (the year of 2003) but the 1993 and 2003 models do not since all the observations in these two models are in the same year (either 1993 or 2003).
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)
3. Observations and Pseudo R-squared values refer to the regressions that precede the pairwise t-tests.

Table 6.6. The Estimated Net Effects of Race, Nativity, and Degree Origin for Women, 1993, and 2003 (90th quantile)

	Total	1993	2003
Asian Race	.0324	.0528	-.00223
	(0.026)	(0.046)	(0.051)
Asian Nativity	-.0255	-.0421	-.0246
	(0.029)	(0.053)	(0.056)
Asian Degree Origin	-.0140	-.132*	.0595
	(0.027)	(0.057)	(0.045)
Observations	5,073	2,531	2,542
Pseudo R-squared	0.20	0.19	0.18

Notes: 1. All control variables listed in Tables 6.1 (for the Total model) and 6.3 (for the 1993 and 2003 models) are used in regression but not reported in this table.
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)
3. Observations and R-square values refer to the regressions that precede the pairwise t-tests.

6.2.2 Gender Differences by Race

Similar to existing literature that reports the earning disadvantages of women scientists and engineers, this study finds that women computer scientists and engineers earn less than comparable men (Table 6.1), and this effect existed in both 1993 and 2003 (Table 6.3) at the 90th quantile point. At the .50 point, women earned less than their male counterparts in only 2003.

More specifically, this study finds internal variations among women computer scientists and engineers. I report the gender difference within each group (whites, Asian Americans, U.S.-educated immigrants, or Asian-educated immigrants) first and next the effect of the "double bind." To examine the gender difference of the four groups, I use the same dependent variable, the natural logarithm of the salary. The key independent variable is the dummy variable, male (male is coded as 1 and female coded as 0). I also include all the control variables used in the models reported in Tables 6.1 and 6.3 except "male."

Quantile regression results show that at the .90 point, white men earn more than comparable white women. As Table 6.7 shows, this effect came solely from 2003—in 2003, they earned 5.8% more than their women counterparts. Also in 2003, among U.S.-educated immigrants, men earned 12.2% more than their female counterparts. The other two groups, Asian Americans and Asian-educated immigrants, had gender differences in 1993 but not in 2003. In fact, Asian American women earned more than their male counterparts in 1993. At the .50 point, no group experienced gender differences in earnings in 1993, but in 2003, two groups, white and Asian American women earned less than their male counterparts.

Table 6.7. Gender Differences in Earnings among the Four Groups, 1993 and 2003 (90th quantile; Female as Reference)

	Total	**1993**	**2003**
Male (Whites)	.0480***	.0323	.0567**
	(0.011)	(0.017)	(0.020)
Male (Asian Americans)	-.0507	-.185***	.0623
	(0.050)	(0.050)	(0.15)
Male (U.S.-educated Immigrants)	.0750	.00185	.115*
	(0.044)	(0.055)	(0.056)
Male (Asian-educated Immigrants)	.0180	.214*	.156
	(0.095)	(0.11)	(0.17)

Notes: 1. The above results are drawn from 12 separate regressions, with three (Total, 1993, and 2003) for whites, Asian Americans, U.S.-educated immigrants, and Asian-educated immigrants each. Each regression includes only one group (such as only whites or only Asian Americans).
2. These models use male as the key independent variable. They use but this table does not report the control variables listed in Tables 6.1 (for the Total model) and 6.3 (for the 1993 and 2003 models) except "male."
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

6.2.3 The Effect of the "Double Bind"

To further investigate the gender difference by race, or more specifically, the effect of double bind, I revise the model reported in Table 6.1 by making whites the reference group and adding the interaction terms of the dummy variables, male, and the three Asian groups into the model. The coefficients of interaction terms indicate the difference of difference. If the coefficient of the interaction term for one group, *e.g.*, male*Asian Americans, is significant and positive, it means when other variables are held constant, the gender difference (the advantage of men over women) is significantly larger for this group—Asian Americans, than for the reference group—whites. This means that Asian American women suffer from the "double bind" effect. In other words, both gender and race play a role in determining Asian American women's earnings, compared with white men. If the coefficient of the interaction term is statistically significant but negative or not statistically significant at all, then I may not argue that the “double bind” effect exists. Results, as reported in Table 6.8, show that at the .90 point, none of the interaction terms is significant. In 1993, the gender difference between U.S.-educated immigrant men and women was smaller than that between white men and women, which does not indicate a double bind effect. In 2003, none of the interaction terms is significant. At the .50 point, in 1993, the gender difference of U.S.-educated immigrants was larger than that among their white counterparts, indicating the double bind effect of U.S.-educated women immigrants in earnings. But in 2003, no group experienced the “double bind” effect.

Table 6.8. Estimated Regression Coefficients from Earning Estimations for the “Double Bind” Effect, 1993 and 2003 (90th quantile)

	Total	**1993**	**2003**
Male*Asian Americans	-.0536	-.0762	.00900
	(0.034)	(0.041)	(0.051)
Male*U.S.-educated Immigrants	-.00795	-.0667**	.00983
	(0.018)	(0.026)	(0.023)
Male*Asian-educated Immigrants	-.0105	-.0466	-.00662
	(0.031)	(0.045)	(0.038)
Observations	31947	17724	14223
Pseudo R-squared	0.20	0.21	0.16

Notes: 1. In the model, in addition to the three interaction terms reported in the table, the independent variables also include the dummies (male, Asian Americans, U.S.-educated Immigrants, Asian-educated Immigrants) and other control variables used in Table 6.1 (for the Total model) and Table 6.3 (for the 1993 and 2003 models).
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

The failure to find the existence of the double bind at the .90 level (but not the .50 level) does not mean that Asian women of all the three groups do not earn less than white men. It means that the gender difference between comparable white men and women is not significantly larger or smaller than that between comparable Asian men and women of each group. To understand the earning differences between each of the four women's groups and white men, I run regressions using the four women's groups and the three Asian male groups (all dummies) as the key independent variables (making white men the reference group) and controlling for all control variables except "male" in models shown in Table 6.3.

I find that compared with their white male counterparts, at .90 point, in 1993, both white and Asian-educated immigrant women earned less (table not shown). In addition, male U.S.- and Asian-educated immigrants also earned less. In 2003, the two male groups and Asian-educated immigrant women did not have earning differences with their white male counterparts, but white women still earned less and U.S.-educated immigrant women started to earn less than comparable white men. At the .50 level, in 1993, compared with their white male counterparts, both U.S.- and Asian-educated immigrants, both men and women, earned less. In 2003, the male groups eliminated earning disadvantages but white and Asian-educated immigrant women had earning disadvantages compared with their white male counterparts (table not shown). In addition, compared with white women, at both the 90th and the 50th quantile points, Asian-educated immigrant women earned less in 1993 but no group did in 2003. Clearly, in either year, some women's groups, including white and the two groups of immigrant women, suffered from earning disadvantages with comparable white men. Furthermore, when the two groups of immigrant men, at both .90 and .50 points, stopped their earning disadvantages over time, the women groups did not. Asian American women did not earn less in either year at either quantile point.

In sum, hypothesis 2a is supported. The effect of the origin of the highest degree existed among both men and women. Hypothesis 2b is supported in that women of the Asian groups earned less than their male counterparts, although some earned less at one quantile point but not the other or in one year but not the other. Hypothesis 2c is partially supported in that U.S.-educated women immigrants suffered from the double bind effect in earnings in 1993 at .50 point but other women's groups did not. Hypothesis 2d is partially supported because although the effect of the degree origin among both men and women and the double bind effect for U.S.-educated women immigrants disappeared over time, the gender difference among some Asian groups, which did not exist in 1993, appeared in 2003.

6.3 Field Variations

This section examines field differences in the earnings of Asian computer scientists and engineers and the changes over time in the field differences. In addition, this section examines differences in earnings between computer scientists and engineers.

6.3.1 Race, Nativity, and Degree Origin Effects for Engineers and Computer Scientists

After controlling for other variables, I find that at the 90th quantile, among engineers, no race or nativity effect exists, but the origin of the highest degree has a negative effect. Asian-educated immigrants earned 11.1% less due to their degree origin in 1993. In 2003, the negative effect of degree origin disappeared (Table 6.9). At the 50th quantile, in 1993, both Asian nativity and degree origin had negative effects. In 2003, while the nativity effect disappeared, the degree origin effect did not. However, the negative Asian degree origin effect narrowed down from 9.9% in 1993 to 7.9% in 2003.

Among computer scientists, at the 90th quantile, race, nativity, or degree origin did not have statistically significant effects in either year (Table 6.9). At the 50th quantile, Asian degree origin had a negative effect (15.7%) in 1993, which disappeared in 2003.

Table 6.9. The Estimated Net Effects of Race, Nativity, and Degree Origin by Field, 1993 and 2003 (90th quantile)

Engineers

	Total	**1993**	**2003**
Asian Race	-.0222	-.0365	.0421
	(0.018)	(0.021)	(0.033)
Asian Nativity	-.0147	-.000481	-.0459
	(0.021)	(0.024)	(0.036)
Asian Degree Origin	-.0747***	-.118***	-.0582
	(0.018)	(0.022)	(0.0315)
Observations	19,073	11,739	7,334
Pseudo R-squared	0.22	0.23	0.18

Computer Scientists

	Total	**1993**	**2003**
Asian Race	.0109	.0174	-0.00502
	(0.026)	(0.034)	(0.033)
Asian Nativity	-.0351	-.0577	-0.0122
	(0.029)	(0.039)	(0.037)
Asian Degree Origin	.0151	-.0296	0.0267
	(0.022)	(0.042)	(0.024)
Observations	12,874	5,985	6,889
Pseudo R-squared	0.19	0.20	0.17

Notes: 1. This table is made from results of two sets of separate regressions (one for engineers and one for computer scientists). Each regression uses a sub-sample of only one field.
2. In the above models, all control variables used in Table 6.1 (for the Total model) and Table 6.3 (for the 1993 and 2003 models) are used but not reported.
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)

6.3.2 Field Difference

Computer scientists earn slightly more than engineers. At the 90th quantile, this difference existed and was similar in both 1993 and 2003—5.2% in 1993 to 5.4% in 2003 (see Tables 6.1 and 6.3). At the 50th quantile, the computer scientists' earning advantage increased from 1.7% in 1993 to 4.6% in 2003.

In sum, hypothesis 3a is partially supported. The effect of the origin of the highest degree existed among engineers at both quantile points but among computer scientists at only 50th and not 90th quantile. Hypothesis 3b is supported in that the findings reveal an earning advantage of computer scientists over comparable engineers. Hypothesis 3c is partially supported. The effects either disappeared or narrowed over time for computer scientists and decreased for engineers. However, the earning differences between engineers and computer scientists actually became larger over time at the 50th quantile.

6.4 Employment Sector Variations

6.4.1 Race, Nativity, and Degree Origin Effects in the Three Sectors

In educational institutions, after controlling for other variables, I find that at the 90th quantile, Asian race has a positive effect. However, this effect existed in only 1993. Also, in 1993, Asian nativity had a negative effect, but it disappeared in 2003 (Table 6.10). At the 50th quantile, Asian race had a positive effect in 2003. Asian degree origin had a negative effect in both years, and the effects were similar—18.1% in 1993 and 18.5% in 2003.

Table 6.10. The Estimated Net Effects of Race, Nativity, and Degree Origin by Employment Sector, 1993 and 2003 (90th quantile)

Educational Institutions

	Total	**1993**	**2003**
Asian Race	.163*	.477***	.0953
	(0.070)	(0.11)	(0.13)
Asian Nativity	-.0896	-.455***	.0546
	(0.079)	(0.12)	(0.15)
Asian Degree Origin	-.122	-.141	-.0569
	(0.064)	(0.13)	(0.14)
Observations	1,486	718	768
Pseudo R-squared	0.28	0.30	0.28

Government

	Total	**1993**	**2003**
Asian Race	0.00916	-.0150	.0605
	(0.026)	(0.035)	(0.061)
Asian Nativity	-0.0444	-0.0395	-.0733
	(0.030)	(0.042)	(0.0691)
Asian Degree Origin	-0.0653*	-0.0563	-.0976
	(0.030)	(0.045)	(0.068)
Observations	4,080	2,525	1,555
Pseudo R-squared	0.24	0.23	0.17

Industry

	Total	**1993**	**2003**
Asian Race	-.0241	-.0323782	.00229
	(0.018)	(0.028)	(0.025)
Asian Nativity	-.00647	-.0237712	-.00815
	(0.020)	(0.031)	(0.028)
Asian Degree Origin	-.0152	-.115***	.00240
	(0.015)	(0.029)	(0.019)
Observations	26381	14481	11900
Pseudo R-squared	0.17	0.17	0.14

Notes: 1. This table is made from results of three sets of regressions (one for educational institutions, one for government, and the other for industry). Each of the three sets uses a sub-sample of only one of the three sectors.
2. All control variables listed in Tables 6.1 (for the Total model) and 6.3 (for the 1993 and 2003 models) are used in regression but not reported in this table. The regressions of government include federal government (state/local government as the reference group), and the regressions of industry include for-profit and non-profit organizations (self-employment as the reference group) as control variables.
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

In government, after controlling for the type of government (federal and state/local) and other variables, I find that at the 90th quantile, the Asian-educated earn less than their U.S.-educated counterparts, but it is an aggregate result since the degree origin effect did not exist in either year (Table 6.10). At the 50th quantile, race or degree origin did not have an effect in either year, but the Asian nativity effect existed in both years, and it increased from 5.5% to 7.5% in 2003.

In industry, after holding the type of industry (self-employed, for-profit, and non-profit) and other variables constant, I find that at the 90th quantile, in 1993, Asian degree origin had a negative effect, but it disappeared in 2003 (Table 6.10). At the 50th quantile, both Asian nativity and degree origin had negative effects in 1993, which disappeared in 2003.

6.4.2 Sector Differences in Earnings

Literature indicates that industry, government, and educational institutions have different environment to female scientists in terms of promotion (Smith-Doerr 2004). Similarly, these sectors may present different earning patterns for Asian computer scientists and engineers. In this section, I use industry as the reference because previous studies have shown that government and educational institutions behave similarly in rewarding and promoting workers but differently from industry. I further disaggregate industry into self-employment, for-profit firms, and non-profit organizations and government into federal and state/local government because even in the same large category, they behave differently from each other in rewarding workers. The number of observations working in educational institutions is relatively small, and as a result, I don’t disaggregate them into four-year or two-year institutions.

Quantile regression results show that compared with industry as a whole (combining self-employment, for-profit firms, and non-profit organizations), at the 90th quantile, educational institutions, federal, and state/local government pay computer scientists and engineers less, and it was true for both 1993 and 2003 (Table 6.11, first columns).

More specifically, when compared with two types of industry, namely, self-employment and for-profit firms, all the three sectors paid comparable workers less in either 1993 or 2003 (Table 6.11, second and third columns). When compared with non-profit organizations, educational institutions and state/local government still paid workers less, but federal government did not have a payment gap in either year (Table 6.11, fourth columns). In some cases, the payment gap of these sectors with industry slightly increased over time. For instance, educational institutions paid comparable computer scientists and engineers 16.1% less than industry in 1993 but 18.6% less in 2003. At the 50th quantile, the patterns in 1993 were similar to those at the 90th quantile. In 2003, the patterns were also similar for educational institutions and state/local government. But federal government not only eliminated payment gap with industry in general and for-profit firms but also paid more than self-employment and non-profit organizations.

In sum, hypothesis 4a is partially supported in that the effect of degree origin existed in some sectors. Hypothesis 4b is supported in that comparable computer scientists and engineers were paid more in industry than other sectors in 1993 and than two of them in 2003. Hypothesis 4c is partially supported in that federal government eliminated paying gap with industry, but educational institutions and state/local government did not narrow their payment gap with industry.

Table 6.11. Differences in Earnings by Employment Sector (90th quantile)

Total	**All Industry As Reference**	**Self-Emp. As Reference**	**For-Profit As Reference**	**Non-Profit As Reference**
Educational institution	-0.188***	-0.591***	-0.181***	-0.107***
	(0.013)	(0.020)	(0.012)	(0.020)
Federal government	-0.0989***	-0.501***	-0.0915***	-0.0173
	(0.0090)	(0.018)	(0.0088)	(0.018)
State/local government	-0.238***	-0.640***	-0.231***	-0.157***
	(0.010)	(0.019)	(0.010)	(0.019)
Observations	31947	31947	31947	31947
Pseudo R-squared	0.19	0.20	0.20	0.20
1993				
Educational institution	-0.175***	-0.690***	-0.164***	-0.0991***
	(0.019)	(0.028)	(0.018)	(0.028)
Federal government	-0.109***	-0.624***	-0.0987***	-0.0336
	(0.011)	(0.024)	(0.010)	(0.024)
State/local government	-0.220***	-0.737***	-0.212***	-0.147***
	(0.014)	(0.025)	(0.013)	(0.025)
Observations	17724	17724	17724	17724
Pseudo R-squared	0.18	0.21	0.21	0.21
2003				
Educational institution	-0.206***	-0.373***	-0.204***	-0.127***
	(0.015)	(0.024)	(0.015)	(0.024)
Federal government	-0.0771***	-0.243***	-0.0737***	0.00333
	(0.013)	(0.024)	(0.013)	(0.023)
State/local government	-0.267***	-0.432***	-0.262***	-0.185***
	(0.013)	(0.024)	(0.013)	(0.023)
Observations	14223	14223	14223	14223
Pseudo R-squared	0.16	0.16	0.16	0.16

Notes: 1. In the above 12 regressions (four total, four in 1993, and four in 2003), other independent variables include the dummies for the three Asian groups (whites as reference) and all control variables reported in Tables 6.1 and 6.3 except employment sectors. These regressions use full samples.
2. When self-employment is used as the reference group, the models also control for for-profit firms and non-profit organizations but not reported in the table. When the for-profit firm is used as reference, the models control for self-employment and non-profit organizations but not reported. Similarly, when the non-profit organization is used for reference, self-employment and for-profit firms are controlled for in the models but not reported.
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

6.5 Nationality Differences

6.5.1 Differences between U.S.- and Asian-Educated Immigrants by Nationality

Earlier sections find that Asian-educated immigrants earn significantly less than their U.S.-educated counterparts, indicating a negative effect of the degree from Asian institutions among both gender, in both fields, and in two employment sectors, but this effect disappeared over time with two exceptions. To further understand the internal differences among Asian computer scientists and engineers of various national origins, I compare U.S.- and Asian-educated immigrants of the same national origin (*e.g.*, U.S.- vs. Asian educated Chinese immigrants) to see whether the earning difference due to the degree origin existed for all or just a few nationalities. Then, I compare the earning patterns of U.S.- and then Asian-educated immigrants, by nationality, with U.S.-born whites. In addition, I examine the internal differences in earnings among U.S.- and then among Asian-educated immigrants to see whether immigrant workers of some nationalities earn more than those of other nationalities among the U.S.-educated and among the Asian-educated. The other reason for focusing on the nationalities of Asian-born computer scientists and engineers but not the ethnicities of Asian Americans in this section is that the dataset does not have the ethnicities of the U.S.-born Asian Americans.

First, to understand the effect of degree origin for workers of different national origins, I run quantile regressions with all Asian-born computer scientists and engineers and use dummy variables for each nationality group (*e.g.*, for the Chinese, Indians, and Koreans) to determine the differences between the U.S.- and Asian-educated. I run 24 regressions in total for the eight nationality groups—eight using the sample that combine

1993 and 2003 data, eight using the 1993 sample, and another eight using the 2003 sample. I report results in Table 6.12.

Table 6.12. Earning Differences between U.S.- and Asian-educated Asian Immigrant Computer Scientists and Engineers by Nationality, 1993, and 2003 (90th quantile; References: Their U.S.-educated Counterparts)

Asian-educated Chinese	-0.115***	0.0214	-0.122*
	(0.031)	(0.054)	(0.048)
Asian-educated Indian	-0.0447*	-0.0972*	-0.0311
	(0.020)	(0.047)	(0.030)
Asian-educated Korean	-0.147*	-0.134	-0.0896
	(0.058)	(0.100)	(0.12)
Asian-educated Japanese	0.281***	0.474***	0.00463
	(0.063)	(0.12)	(0.11)
Asian-educated Taiwanese	0.00371	-0.0361	0.0452
	(0.051)	(0.085)	(0.11)
Asian-educated Filipino	-0.0706	-0.127	-0.00829
	(0.040)	(0.077)	(0.067)
Asian-educated Vietnamese	-0.135*	-0.142	-0.515***
	(0.063)	(0.12)	(0.065)
Asian-educated Others	-0.104	-0.156*	-0.129
	(0.059)	(0.070)	(0.077)

Notes: 1. I run 24 regressions separately and report results from the 24 regressions into the above table. Each of the regressions uses all U.S.- and Asian-educated groups with one Asian-educated group as the reference.
2. The regression models use control variables used in Tables 6.1 and 6.3.
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level (p<0.05)
** coefficient statistically significant at 0.01 level (p<0.01)
*** coefficient statistically significant at 0.001 level (p<0.001)

In general, at the 90th quantile, in four out of the eight nationality groups, Asian-educated immigrants earn significantly less than their U.S.-educated counterparts, with the Asian-educated Japanese earning more than their U.S.-educated counterparts. But disaggregating data reveals the disadvantages that in 1993, only Asian-educated Indians and the Other group earned less due to their Asian degree origin, but the Asian-educated Japanese earned more. In 2003, the earning advantages and disadvantages of the above groups disappeared, but Asian-educated Chinese and Vietnamese earned less than their

U.S.-educated counterparts. At the 50th quantile, in 1993, more Asian-educated nationality groups suffered from their degree origin—Koreans, Filipinos, the Vietnamese, and Others earned less, and the Asian-educated Japanese and Indians earned more than their U.S.-educated counterparts. In 2003, four groups—Asian-educated Filipinos and Vietnamese still and also the Chinese and Indians earned less due to their degree origin.

The above findings suggest that the disadvantages of Asian-educated Asian computer scientists and engineers were the results of some but not all nationality groups. For some of them, the earning disadvantages due to their highest degrees obtained in an Asian institution disappeared over time. For some, they continued. For others, the earning disadvantages due to degree origin that did not exist in 1993 started in 2003.

6.5.2 Compared with Whites by Nationality

Compared with their white counterparts, not all U.S. or Asian-educated immigrants are disadvantaged. Among the U.S.-educated, at the 90th quantile, two groups, Koreans and the Taiwanese, were disadvantaged. Disaggregating data shows that in 1993, the Taiwanese earned significantly less than comparable whites. However, in 2003, not only their disadvantages disappeared, but also Indians started to earn more than their white counterparts (Table 6.13). At the 50th quantile, in 1993, more groups earned less than comparable whites. More specifically, U.S.-educated Chinese, Koreans, Taiwanese, and Vietnamese did. In 2003, similar to the results at the 90th quantile, the earning disadvantages of these groups disappeared, and Indians earned more than their white counterparts.

Table 6.13. Earning Differences of U.S.-educated Asian Immigrant Computer Scientists and Engineers Relative to Whites by Nationality, in Total, 1993, and 2003 (90th quantile; Reference: Their U.S.-born White Counterparts)

	Total	**1993**	**2003**
U.S.-educated Chinese	-0.0253	-0.0374	-0.0138
	(0.014)	(0.019)	(0.018)
U.S.-educated Indian	0.0201	-0.0241	0.0406*
	(0.014)	(0.019)	(0.020)
U.S.-educated Korean	-0.0562*	-0.0613	-0.0228
	(0.027)	(0.037)	(0.037)
U.S.-educated Japanese	-0.00519	0.0209	0.0687
	(0.046)	(0.053)	(0.063)
U.S.-educated Taiwanese	-0.0507**	-0.0552*	-0.0447
	(0.017)	(0.022)	(0.024)
U.S.-educated Filipino	-0.00578	0.0137	-0.0612
	(0.034)	(0.054)	(0.046)
U.S.-educated Vietnamese	-0.000744	-0.0251	0.0191
	(0.020)	(0.026)	(0.027)
U.S.-educated Others	0.0329	0.00439	0.0235
	(0.021)	(0.033)	(0.027)
Observations	29828	16758	13070
Psedo-R2	0.21	0.21	0.17

Notes: 1. This regression models use a sub-sample of whites and U.S.-educated immigrants. They use control variables used in Tables 6.1 and 6.3.
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

Unlike their U.S.-educated counterparts, when compared with their white counterparts, more Asian-educated groups had disadvantages in each year. At the 90th quantile, in general, all groups earned significantly less than comparable whites except the Japanese, who earned more than their white counterparts. In 1993, six groups were disadvantaged. In 2003, two of them, namely, Koreans and the Vietnamese, as well as the Chinese earned less than comparable whites (Table 6.14). Over time, Asian-educated Indians, Taiwanese, Filipinos, and Others gained earning equity with comparable whites, and the Japanese’s earning advantage over whites in 1993 (17.5% more) disappeared in 2003. At the 50th quantile, in 1993, six groups earned less than their white counterparts, and in 2003, four groups, namely, Asian-educated Chinese, Taiwanese, Filipinos, and Vietnamese did. Similar to at the .90 level, the Japanese advantage over whites at the .50 level disappeared in 2003.

Table 6.14. Earning Differences of Asian-educated Asian Immigrant Computer Scientists and Engineers Relative to Whites by Nationality, in Total, 1993, and 2003 (90th quantile; Reference: Their U.S.-born White Counterparts)

	Total	**1993**	**2003**
Asian-educated Chinese	-0.198***	-0.0844	-0.185***
	(0.037)	(0.066)	(0.050)
Asian-educated Indian	-0.0689**	-0.129***	-0.0463
	(0.025)	(0.037)	(0.036)
Asian-educated Korean	-0.202***	-0.215**	-0.210*
	(0.060)	(0.080)	(0.11)
Asian-educated Japanese	0.153**	0.161*	-0.0437
	(0.055)	(0.081)	(0.086)
Asian-educated Taiwanese	-0.106*	-0.148*	-0.0677
	(0.051)	(0.062)	(0.094)
Asian-educated Filipino	-0.144***	-0.182***	-0.0584
	(0.023)	(0.030)	(0.043)
Asian-educated Vietnamese	-0.242**	-0.256**	-0.438***
	(0.086)	(0.096)	(0.051)
Asian-educated Others	-0.115*	-0.217**	-0.0504
	(0.053)	(0.069)	(0.074)
Observations	27153	15500	11653
Pseudo R-squared	0.20	0.22	0.16

Notes: 1. This regression models use a sub-sample of whites and Asian-educated immigrants. They use control variables used in Tables 6.1 and 6.3.
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

The findings regarding the differences between whites and U.S.-educated immigrants and between whites and Asian-educated immigrants suggest that while U.S.-educated immigrants overcame earning disadvantages over time and in fact, one group (Indians) earned significantly more than comparable whites in 2003, Asian-educated immigrants did not progress as well. Some nationality groups consistently earned less in both years, and others did not earn less in 1993 but did in 2003.

6.5.3 Internal Differences by Nationality

Earlier discussions show that some groups, such as Indians, both U.S.- and Asian-educated, fared better than most other nationality groups (see Tables 6.11 to 6.14). In the following analysis, I use Indians as the reference group to examine the internal variations. At the 90th quantile, among U.S.-educated immigrants, four groups earn less than their Indian counterparts (Table 6.15). In 1993, no group earned less, but in 2003, the Taiwanese and Vietnamese did. At the 50th quantile, compared with comparable Indians, only Koreans earned less in 1993, but in 2003, five groups did—the Chinese, the Taiwanese, Filipinos, Vietnamese, and Others did.

Among the Asian-educated, compared with their Indian counterparts, at the 90th quantile, the Chinese and the Vietnamese earn significantly less but the Japanese earn more. The earning disadvantages of the first two groups were the results of 2003 but not 1993. Furthermore, the Japanese's earning advantage over Indians which existed in 1993 disappeared in 2003 (Table 6.16). At the 50th quantile, in 1993, Koreans earned less than comparable Indians but in 2003, Filipinos and the Vietnamese did.

The above results show that net of other factors, U.S.- and Asian-educated Indians fared better than some groups in both 1993 and 2003. In both categories, I find internal differences that are reflected in the differences between Indians and other nationality groups with comparable characteristics.

Table 6.15. Earning Differences among U.S.-educated Asian Immigrant Computer Scientists and Engineers, by Nationality (90th quantile; Reference: Their U.S.-educated Indian Counterparts)

	Total	**1993**	**2003**
U.S.-educated Chinese	-0.0616**	-0.0124	-0.0503
	(0.021)	(0.031)	(0.026)
U.S.-educated Korean	-0.0875**	-0.0366	-0.0639
	(0.033)	(0.053)	(0.038)
U.S.-educated Japanese	0.0413	0.0766	0.00807
	(0.056)	(0.076)	(0.071)
U.S.-educated Taiwanese	-0.0812**	-0.0531	-0.0904**
	(0.025)	(0.036)	(0.032)
U.S.-educated Filipino	-0.0593	0.0280	-0.113*
	(0.044)	(0.069)	(0.053)
U.S.-educated Vietnamese	-0.0674*	-0.0466	-0.0806*
	(0.031)	(0.049)	(0.037)
U.S.-educated Others	-0.0115	0.0124	-0.0140
	(0.029)	(0.046)	(0.033)
Observations	3941	1740	2201
Pseudo R-squared	0.23	0.22	0.23

Notes: 1. This regression models use a sub-sample of only U.S.-educated immigrants. The control variables are the same as those reported in Tables 6.1 and 6.3.
2. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

In sum, hypotheses 5a, 5b, and 5c are supported. The degree origin effect existed among some nationality groups. When compared with whites, among both the U.S.- and the Asian-educated, some groups earned less or more, but others did not. In addition, among both the U.S.- and the Asian-educated, some nationality groups earned less than Indians while others did not. Hypothesis 5d is partially supported in that the some of the nationality groups closed their earning gaps with their white and/or Indian counterparts over time, but other groups who did not earn less than whites and/or Indians in 1993 did in 2003.

Table 6.16. Earning Differences among Asian-educated Asian Immigrant Computer Scientists and Engineers, by Nationality (90th quantile; Reference: Their Asian-educated Indian Counterparts)

	Total	**1993**	**2003**
Asian-educated Chinese	-0.117***	0.130	-0.193***
	(0.032)	(0.16)	(0.037)
Asian-educated Korean	-0.0741	0.00723	-0.0433
	(0.055)	(0.18)	(0.11)
Asian-educated Japanese	0.269***	0.588***	0.0738
	(0.045)	(0.15)	(0.060)
Asian-educated Taiwanese	0.0409	-0.0119	0.0814
	(0.051)	(0.15)	(0.078)
Asian-educated Filipino	-0.0375	-0.0402	-0.0311
	(0.030)	(0.12)	(0.047)
Asian-educated Vietnamese	-0.118*	-0.136	-0.444***
	(0.060)	(0.13)	(0.057)
Asian-educated Others	-0.0817	0.0832	-0.0878
	(0.051)	(0.19)	(0.064)
Observations	1266	482	784
Pseudo R-squared	0.17	0.23	0.16

Notes: 1. This regression models use a sub-sample of only Asian-educated immigrants. The control variables are the same as those reported in Tables 6.1 (for the Total model) and 6.3 (for the 1993 and 2003 models).
3. Standard errors in parentheses
* coefficient statistically significant at 0.05 level ($p<0.05$)
** coefficient statistically significant at 0.01 level ($p<0.01$)
*** coefficient statistically significant at 0.001 level ($p<0.001$)

CHAPTER 7

DISCUSSIONS

Previous chapters have reported findings about the effects of race, nativity, degree origin, gender, field, employment sector, and nationality. Some of them are consistent with those in the literature, and others provide new insights towards understanding the earnings of Asian computer scientists and engineers. This chapter compares the findings with the literature and analyzes these findings in the context of theoretical frameworks.

7.1 The Roles of Race, Nativity, and Degree Origin

This study finds that race (being Asian vs. white) had a statistically significant effect on earnings among men (negative) at the 90th quantile and in educational institutions (positive) in both quantile points but not in other cases (among women, in either field, or among other employment sectors) in either the 90th or 50th quantile. That Asian American men earned less than their white counterparts in 1993 could indicate the white advantage in earnings among men. However, this white advantage was limited to males. That this effect did not exist among women in the same year could be explained by the fact that white women earned much less than their male counterparts, and the earning difference between comparable white and Asian American women was much smaller and not statistically significant. More details about women will be discussed in the next section on gender. The finding that the negative effect of Asian race disappeared in 2003 indicates that Asian American men achieved earning equity with their white counterparts.

That Asian Americans earned more than whites in educational institutions may be explained by Tang's (2000) finding that in academic engineering, Asians are more likely than whites and blacks to work in R&D. Although the type of work activity is controlled in the models, Asian Americans were likely paid better in educational institutions than comparable whites due to their perceived technical excellence. However, this finding could be influenced by the small number of Asian Americans in the sample. There were only 21 Asian Americans each in educational institutions in 1993 and 2003, with a total of 42. Thus, readers have to be careful in interpreting or generalizing the above finding. Furthermore, the finding that Asian race was not statistically significant in other cases is consistent with that in some previous studies (see Chiswick 1983; Iceland 1999), which report no statistically significant racial differences in earnings between U.S.-born white and Asian workers in the U.S.

Again, readers have to be cautious in interpreting the results that race does not lead to earning disparities for Asian computer scientists and engineers. First, the failure of finding statistically significant effect of race in most cases is likely due to the small number of Asian Americans in the sample. Second, a lack of earning disadvantage does not mean that Asian American and U.S.-educated immigrant computer scientists and engineers are not disadvantaged in other aspects of their careers. Earlier discussions on the "glass ceilings" in various sectors and systematic racism for Asian scientists and engineers reveal the structural constraints that they experience in organizations and in the broader society. Their concerns primarily include barriers they receive in promotion but in other aspects as well, such as the feeling of not being trusted in the workplace.

Consider the fear of Asian scientists and engineers in national labs after the Wen Ho Lee incident.

This study also finds that nativity (being Asian-born vs. U.S.-born) had a negative effect in 1993 in educational institutions at the 90th quantile. At the 50th quantile, this negative effect existed among men, engineers, government, and industry, and it disappeared in 2003 in all cases but government, in which the negative effect of Asian nativity increased by 2%. The finding that the Asian-born had earning disadvantages due to their nativity in 1993 is consistent with that in earlier studies that report the earning disadvantages of foreign-born (not just Asian) S&E workers compared with their native-born counterparts in the late 1980s and the mid-1990s (Espenshade et. al 2001). This study updates earlier studies by tracking the changes over time and finds that the negative effect of being born in Asia disappeared over time with one exception.

A more notable finding of this study is the effect of degree origin with a disadvantage of the Asian-educated. In the 90th quantile, this effect existed among both gender, in both fields (engineers and computer scientists), and in two of the three employment sectors (educational institutions and industry) in 1993. But it disappeared in 2003 except among engineers and in educational institutions. In the 90th quantile, the degree origin effect existed in fewer cases—among men, women, engineers, and in industry, and it disappeared in all the cases in 2003. The findings show that the race, nativity, and degree origin effects had more and greater influences at the median (the 50th quantile) than in the upper tail (the 90th quantile).

The findings regarding the degree origin effect are partly consistent with previous studies. The results lend support to Zeng and Xie's (2004) finding that among male Asian workers (not just computer scientists and engineers) in the U.S., while those who finished education before moving to the U.S. suffered from earning disadvantages due to their place of education. This study finds that this was true for male and also female Asian computer scientists and engineers as well as in other cases in 1993. Unlike Zeng and Xie's (2004) work that does not track change over time, this study finds that the effect of degree origin disappeared over time in most cases.

The negative effect of Asian highest degrees in 1993 found in this study could be explained by factors related to the education or human capital that Asian-educated immigrants received in Asia, *e.g.*, the real or perceived lower quality of the highest degree from an Asian higher education institution. More specifically, it may be explained by the quality of science and engineering education and English education in Asia. According to the systematic racism theory, the Asian-educated could be oppressed in payment due to their degree origin. The disappearance of this effect in 2003 could be accounted for by the real or the perceived improvement in the quality of education in Asia.

The cases in which the effect of degree origin remained were among engineers and in educational institutions. For Asian-educated engineers (but not computer scientists), their degree origin continued to place them at a disadvantage, but the negative effect of the highest degree from an Asia institution narrowed over time. In educational institutions, this effect was consistent in both years. It could be due to the fact that the research capacities of Asian universities did not improve much over time (Cookson 2005), and graduates from Asian universities are disadvantaged in earnings in the U.S. educational institutions.

The improvement in the human capital with an Asian origin over time does not come from vacuum. It is a result of the structural change in the education system in Asia. Furthermore, the disappearance of the degree origin effect is not solely due to the improvement in the human capital from Asia but also due to structural changes in the U.S., such as changes in public policies regarding the science and engineering workforce in the U.S. The changes in the degree origin effect over time suggests the interplay of structural forces and human capital.

In the next parts of the section, I present the status of education in general and that in English and science and engineering in specific in various Asian countries. Then, I discuss the change of the degree origin effect over time. It might be too simplistic to treat education in all Asian countries as the same, but these countries do present similar patterns in terms of the quality of their higher education.

7.1.1 Education in Asia

Studies report that the Asian approach of developing human resources is quite different from that of the West. In Asia, government coordinates education and research. The Asian countries place high priority on universal elementary education, which reflects their belief that excellent performance is based on a good command of the basics. Asian countries do not invest as much on secondary and tertiary education. Within secondary and tertiary education, the priority is placed on some critical fields, such as the sciences and engineering. These fields are believed to be helpful to the nations in catching up and moving ahead (Cummings 1995). The investment in higher education has been increased recently in many Asian countries to catch up and improve their scientific and technological competitiveness (Yusuf and Nabeshima 2007).

However, a common negative feature of education among some countries in Asia, especially East Asia, is that it does not promote creativity. Kim (2005) reports that East Asian countries often emphasize and expect memorization and repetition at the cost of creativity. In East Asia, Confucianism influences education in multiple ways, such as the societal high regard for education. Asian governments invest a higher share of gross domestic product in education than other countries, and parents consistently support their children's educational success. Students often positively respond to the societal and their parents' expectations to work hard and succeed in school. Nevertheless, the Confucian culture, believing in efforts and expecting a respect to teachers, limits creativity. More specifically, creativity can be stifled to a large degree through the multiple practices, such as rote learning and a work-play dichotomy with a devaluation of play. Creativity can also be limited due to the value system that emphasizes obedience and loyalty in the hierarchical structure that expects different gender roles and the authority of teachers. All these practices are found in society and school, and as a result, students are socialized to be psychologically dependent on the community and avoid conflict. People avoid behaving differently from others and are afraid of making mistakes or feeling embarrassed because of the mistakes, which can keep them silent in class. In Korea, for instance, the goal of education is to prepare students to pass examinations, and the teacher-centered learning environment does not promote creativity or critical thinking. In short, influenced by its culture, education in East Asian countries tends not to foster creativity in their education. In contrast, the U.S. education, despite its relatively low social support for educational achievement and high dropout rates, emphasizes creativity. Students are encouraged to inquire and express their ideas through open and free discussions. They are also encouraged to explore, test, and modify ideas, and work through experimenting (Kim 2005).

7.1.2 Science and Engineering Education in Asia

Data show that some Asian countries, such as China and India, produce a large quantity of science and engineering graduates every year, and their numbers are far larger than that of the U.S. (NSB 2008). However, Gereffi and Wadhwa (2005) argue that the numbers are misleading. They find that a large proportion of the numbers of S&E degrees is similar to the associate degrees in the U.S. In addition, one has to consider the population size of the countries. For instance, in 2003, China reported to have graduated over 644,106 students in engineering, computer science, and information technology. However, about 55% of them had four-year degrees, and 45% had subbaccalaureate degrees. In India, the total number was 215, 000, of which 52% were bachelor’s and 48% were subbaccalaureate degrees. In the same year, the U.S. produced over 222,335 such degrees, of which 62% were bachelor’s degrees, and 38% were associate degrees. Considering the large population of China and India—around 1.29 billion for China and 1.07 billion for India in 2003 (China.org.cn 2009; nationsencyclopedia.com 2009), the U.S. in fact outnumbered China and India in terms of S&E baccalaureate degrees in these fields per million citizens (1.1 and 2.8 times as much as those of China and India, respectively).

A more important question is the quality of these degrees in Asia. Asian academics in the U.S. criticized the quality of their countries’ engineering programs. Mooney and Neelakantan (2006) report that Chinese and Indian scientists and engineers criticize the standards, faculty, and training in China and India. These countries lack such resources as faculty and facilities, and as a result, the students do not receive adequate advice and mentoring from faculty. In India, only about 4,000 engineering graduates in 2006 graduated from the seven branches of the prestigious Indian Institute of Technology, and no more than 150 other institutions out of a total of 1,346 officially recognized engineering colleges are regarded to be of good quality. A McKinsey report cited by Gereffi et al. (2008) shows that in 2005, while 80.7% of U.S. engineers were globally employable (employable to multinational corporations), only 10% of Chinese engineers and 25% of Indian engineers were. The perceived barriers to engineers in China and India included the quality of their degrees, cultural barriers, and especially applicable to China, deficiency in the English language.

Nevertheless, science and engineering education in Asia has considerably improved over time. In China, for instance, science and engineering education had a severe setback in the 1960s and 1970s due to the Cultural Revolution and made some progress in the 1980s and the 1990s. In the 1980s, about 70% of science teachers in junior middle schools and 40% of science teachers in senior middle schools were inadequately trained, especially in teaching skills. In schools, classes focused on lectures and demonstration but did not provide sufficient opportunities for students to do experiment in the lab and experience science and nature that way (Lewin 1987). In the 1990s, the situation in terms of resources, teacher training, and methods of instruction were similar (Wang et al. 1996). At the college level, in terms of computer science education, again, China made substantial progress in many aspects in the late 1980s, such as developing computing machines and software and obtaining equipment from overseas. However, problems remained. These problems included a lack of latest hardware and software, research journals, and textbooks. In addition to the lack of facilities, China had a shortage of teachers in computer science in the 1980s (Wilson et al. 1988). Researchers also point out that the education of material science and engineering (MSE) in China was quite solid and the standards were internationally acceptable. However, MSE education faces challenges, such as outdated equipment, a shortage of teaching materials and modern educational facilities and methods, a lack of interdisciplinarity, and a lack of efficiency of educational institutions (Li and Zuo 1995).

To raise indigenous innovation capabilities and to involve more enterprise-level research, in 1995, China launched its now well-known national strategy, “Revitalizing the Nation through Science, Technology, and Education” (*kejiao xingguo)*. Since then, China has increased its funding for research and education in science and technology and launched programs to improve the standards of science and education in China. of course, challenges remain—insufficient funding, a shortage of high-quality researchers, low quality of research, weak high-tech capabilities (Cao 2002), a restructuring of the hierarchical structures inside many academic departments that define the focus and content of teaching and research instead of researchers, finding a balance between teaching and research, and being cautious about focusing on applied research (Yusuf and Nabeshima 2007).

In addition, changes occur due to globalization. For instance, computer science education in Asia has improved a lot from 1993 to 2003. Starting from the early 1990s, some multinational corporations started to outsource software development and other computer science jobs to Asia, notably India. The purposes of the outsourcing of these jobs included to cut personnel costs and to satisfy the personnel shortage in certain countries (Kobitzsch, Rombach, and Feldmann 2001). The availability of these jobs in Asia also raised the bar for the quality of computer science graduates in Asia.

7.1.3 English Education in Asia

Another important factor that influences the perceived quality of Asian education is that most Asian countries do not use English as the language of instruction, although English is the main foreign language taught in school.[9] In some countries, the quality of English education is problematic, and many college graduates do not speak fluent English. The level of English proficiency is important because one stereotype for Asians is that they do not speak English well, and the quality of English education in Asia, with some exceptions, such as in India and Singapore, more or less confirms this stereotype. English proficiency is probably less determining to entering S&E fields than other fields, such as humanities and social sciences, which have much higher requirements on English for study and communication. However, it may disadvantage Asian-educated computer scientists and engineers in various aspects of their careers, such as promotion to management and other leadership positions. Even for non-management positions, good English skills are often rewarding, and those who are perceived to be lack of English proficiency may be at a disadvantage in earnings.

English as a global language has impact on educational policies and practices in Asia, yet some problems remain unsolved. Among them, the most prominent and persistent problem is the lack of qualified English teachers and the use of unqualified or inadequately-trained English teachers. This is true for Mainland China, Hong Kong, Japan, Korea, Malaysia, Taiwan, Vietnam (Nunan 2003), and the Philippines (Waters and Vilches 2008). Even in Hong Kong, a region that is economically more developed than some of the other countries or regions covered in the study and has spent millions of dollars in teacher education in recent years, the wide use of nonqualified English teachers in public schools are quite problematic (Nunan 2003).

The underprepared teachers lead to problems in instructions. Nunan (2003) finds that communicative language training (CLT), a strategy of teaching English through interaction and communication, is believed to be more efficient than the traditional way that emphasizes reading and writing. However, teachers in Asian countries do not thoroughly understand CTL. More often than not, teachers emphasize reading and writing skills so that students can pass entrance examinations to high schools and colleges. Pennington et al. (1997) compare the college English writing education in five Asian-Pacific countries, Australia, New Zealand, Hong Kong, Japan, and Singapore. They find that Australia and New Zealand are more process-oriented, and Hong Kong, Japan, and Singapore are more product-oriented. While the product approaches has a limited, utilitarian purpose and emphasizes the final product as a qualification of passing exams, the process approach aims at a broad-range human experience and promoting and enhancing students' critical thinking skills through writing. Among the Asian countries, Japan has the most product-oriented approach. In Hong Kong and Singapore, the process end is closer to teachers' ideal than their actual practice. The authors attribute some teachers' lack of commitment to process writing to their inadequate training and limited knowledge in writing and linguistics in some cases. In others, teachers are adjusting the new theoretical and practical knowledge to meet the requirements of actual circumstances, including the culture of learning in the nation.

Yet, positive changes occurred in these countries. For instance, in China, Lam (2002) reveals a steady increase in the learning experience over four age cohorts (46-50, 41-45, 36-40, 29-35, and 24-28 years old in 2000 when the survey was conducted). She finds that younger cohorts report statistically significantly more foreign-language class time and teacher's use of the target language in class in elementary, secondary, and tertiary institutions. For learners, more and better facilities, such as tape recorders, more books, and campus radio, were available to the younger cohorts, who were also more open to speaking and practicing English than older cohorts.

In sum, in addition to the general status of education and the science and engineering education in Asia, the lower quality of English education in Asia may also explain the disadvantage of Asian-educated computer scientists and engineers, especially if they received their highest degrees in the 1990s or earlier. The lack of English proficiency may influence Asian-educated computer scientists and engineers in their communication with colleagues and supervisors in meetings, presentations, reports, etc. Yet, the improvement in education in Asia may account for the change in the effect of degree origin on the earnings of Asian-educated computer scientists and engineers from 1993 (significantly negative effect) to 2003 (negative but statistically insignificant).

7.1.4 Other Possible Factors

Another possible explanation for earning disparities between U.S.- and Asian-educated immigrants with comparable level of degree and other characteristics in 1993 is that some foreign IT workers, especially from Asia, were willing to be underemployed (NRC 2001). This situation may be true for all immigrants, either U.S.- or Asian-educated, but it could be especially true for the latter because their human capital might be devalued or that they did not have much social capital—no or few references or connections in the U.S.

The underemployment could be due to their voluntary choice based on the types and the number of jobs available to them in the U.S. Since their level of education make them more competitive than other job candidates with lower educational level, these jobs become their means of entry to the U.S., and the payment is still higher than they may be paid for higher-level positions in their home countries. In addition, workers on H-1B visas seeking for permanent residency may choose to stay with the same employers because if they switch employers, their previous efforts on visa and permanent residency applications will be invalidated, and they will have to start their applications again. Then, they have less bargaining power than if they have more choices. But the underemployment and the resulting underpayment could also be due to their segregation into doing certain tasks that were paid less than others even when these positions share the same job title as a computer scientist or an engineer.

7.1.5 The Interplay of Structure and Human Capital—Explaining the Changes in Asian Education and the Changes in the Effect of Degree Origin

As described earlier, Asian education, especially S&E and English education, has experienced some positive changes over time. All the changes could be understood in the broader context of globalization and the structural changes in the higher education systems and the broader society in Asian countries. Globalization enables many countries to import successful public policies from other world regions (Dobbin et al. 2007). Starting from the 1980s and the 1990s, many Asian countries started to adopt educational practices in the West. For instance, Min (2004) reports that China realized the problem of overspecialization of the college curriculum, especially in science and engineering, a tradition of the Soviet model, and the resulting narrow knowledge of college graduates who often worked in fields where their training did not benefit their work. The opening up of China facilitated the efforts to transform education in this regard. Since the mid-1980s, reforms have been introduced into universities and colleges to broaden the fields of specialization in S&E fields and introduce social sciences and humanities courses for S&E students. Some universities have experimented with the western models, in which freshmen and sophomores take general education courses, and juniors and seniors take major-related courses. Meanwhile, reforms also emphasize the transition from memorization of knowledge to the fostering of creative and critical thinking skills, problem-solving skills, and intellectual independence. Yet, these reforms are implemented unevenly—they are implemented faster in leading national universities than local colleges or those in remote areas due to various factors, including more qualified faculty and better resources in the former than the latter.

Another Asian country, Singapore has been making efforts to becoming an international center of learning. Universities and polytechnics in Singapore were initially modeled after the British system, but starting from the 1990s, North American academic model had more influence. For instance, they chose as role models the Massachusetts Institute of Technology and Harvard University, which were later replaced by the University of California. The Singapore Management University was officially incorporated in 2000 based on the model of Wharton Business School. In addition, more collaborations were established, such as attracting prestigious foreign universities to set up branch campuses in Singapore (Tan 2004).

In India, an initiative from the private educational institutions is called the "twining program," which involves the collaboration of two educational systems at the international level (one Indian institution and an abroad institution) or the domestic level (two educational systems in India) in educating students. This is especially true in certain academic fields, such as computer science. The purpose of this initiative is to open Indian higher education to foreign educational institutions and to improve the competitiveness of Indian students as potential students and/or workers in the global market (Jayaram 2004). Other Asian countries, such as Thailand, have also introduced academic exchange programs and joint course offerings with foreign higher education institutions in the 1990s (Sinlarat 2004).

In the meantime, Asia and the U.S. have become more closely connected. Saxenian's (2006) description provides an excellent account of the flow of talent between the U.S. and Asia. Asian immigrants working in the Silicon Valley go back to their home countries in Asia and set up a global network for collective innovation. Not only the improvement in higher education can change the world's perception but also the closer collaboration between Asia and the West can. Friedman (2005) argues that "the world is flat," referring to the fact that different regions in the world are having a level playing field with the closer connection of the different regions. Graduates of Asian higher education institutions have a wider social network or more social capital, which could help with their employment opportunities in the U.S. as well as other world regions in addition to Asia. Furthermore, the improvement in the quality or the integration of Western, especially American, higher education models in Asia, together with the closer connection and collaboration between Asia and the U.S. may change employers' perceptions of Asian degrees.

In addition, the disappearance of the negative effect of Asian highest degrees may be due to policy changes regarding the S&E workforce in the U.S. The U.S. legislation increased the H-1B visas over time. The legislation in 1990 increased immigration based on employment from earlier years, including scientists and engineers entering the U.S. on H-1B visas. Additional H-1B visas were authorized for FY1999 to include 21,888 – 23,385 extra visas that were inadvertently approved, exceeding the cap that year. In 2000, the H-1B and the employment-based immigration programs were considerably changed, again raising the annual number of H-1B visas for FY2001, FY2002, and FY2003 to 195,000 (the normal ceiling was 65,000). Also under the law, non-immigrants who are employed by higher education institutions and nonprofit or governmental research organizations are excluded from the H-1B cap (Matthews 2008). The changes in the legislation in 1999 and 2000 could have contributed to the disappearing of statistically significant earning disadvantages of Asian-educated workers because more opportunities became available to them than before. Meanwhile, some scholars are concerned that visa restrictions limit the bargaining power of immigrant workers (NRC 2001). The legislation change could have slightly increased the bargaining power of immigrants on work visas.

The interplay of human capital and the structure at the organizational level is reflected in the changing earning patterns of Asian-educated computer scientists and engineers relative to their U.S.-educated counterparts in the U.S. workplace. The interplay is depicted in Figure 6.1. Both structures and human capital can explain the changes in earning patterns. Structural changes can influence the quality of human capital in a certain region as well as the acceptance of human capital obtained from this region in the host country. On the one hand, in Asia, the changes in the education systems lead to an improvement in the quality of human capital obtained in Asia. The closer connections between Asia and the U.S. lead to more social capital that can benefit the Asian-educated in the U.S. labor market. Both are the impact of globalization. On the other hand, in the U.S., the changing S&E workforce and immigration policies provide a more favorable environment for Asian-educated workers in finding employment. The changing immigration policies may also have a positive impact on employers' perceptions regarding the human capital obtained in Asia—to attract the "best and brightest" from the world rather than just the U.S. All the three factors combined may lead to the fact that over time, employers pay Asian-educated immigrant workers similarly to their U.S.-educated counterparts or still less but not reaching the power of statistically significance.

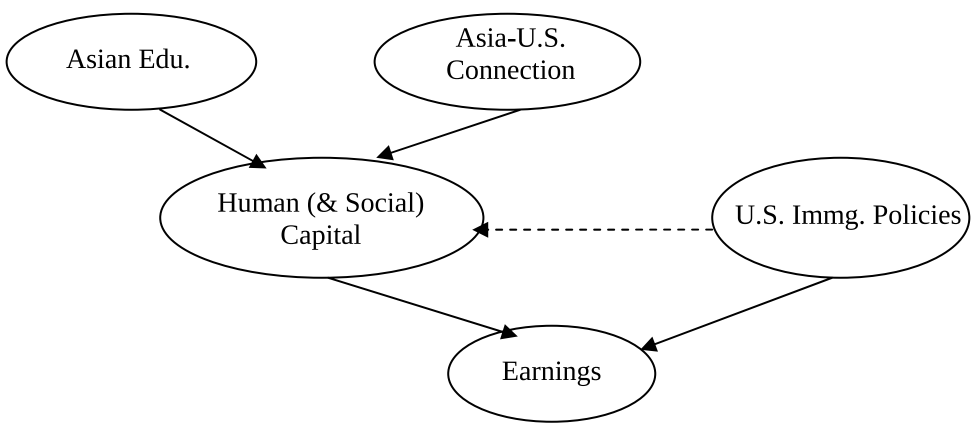

Figure 6.1 The Interplay of Structural Forces and Human Capital

Please note that this is not to say that the Asian degree has improved its quality to such a level that it is factually of the same quality as that of the U.S. degree—it is very hard to accurately define and measure the quality and is clearly beyond the scope of this study. This study examines the interplay of human capital obtained in a certain region and structural factors in various settings. It analyzes how the interplay of these factors can change employers' perceptions towards region-specific human capital and change pay gap for the Asian-educated over time.

7.2 Gender Differences in S&E

7.2.1 Gender Differences by Race

At the 90th quantile, Asian-educated immigrant women in 1993 and white and U.S.-educated immigrant women in 2003 had statistically significant earning disadvantages compared with their male counterparts. At the median, white and Asian American women earned less than their male counterparts in 2003. The findings are somewhat consistent with the findings of previous studies that report women's earning disadvantages among scientists and engineers. Yet, previous studies tend to aggregate data—treating women as a whole, and the majority of the samples for women in previous studies tend to be white women, masking the internal differences among women.

The failure of finding female disadvantages among Asian Americans at the 90th quantile may be explained by factors that have been discussed in previous studies. For instance, Asian American women may benefit from statistical discrimination that is discussed in Tang's (1997) and Gatchair's (2007) studies. The statistical discrimination model argues that due to the limited information on a job candidate's productivity that is available to an employer, the employer tends not to hire him or her if the employer's general perception towards his or her group is not favorable. Statistical discrimination is also likely to work in rewarding workers, especially if the employer does not have clear or objective evaluation criteria. Asians tend to be described as being good at conducting scientific and technical tasks, and this perception may be extended to Asian American women in the upper tail to such a degree that they earned more than their male counterparts.

7.2.2 Double Penalty Revisited

As is discussed, most studies on women scientists and engineers do not disaggregate data by race. The few studies that examine women of color show that the findings of women are not always applicable for Asian women. Compared with Tang's (1997) study, this study further disaggregate data by the origin of the highest degree. The findings in this study partly confirm Tang's findings that in either quantile, native-born Asian American women do not suffer from "double penalty." In addition, Asian-educated immigrant women did not suffer from the "double bind," either. However, U.S.-educated immigrant women suffered from the double bind effect in 1993 at the 50th quantile (but not the 90th quantile). At the median, U.S.-educated immigrant women earned less due to both their gender and race, but their double bind disappeared in 2003.

That most Asian women's groups did not suffer from double penalty in earnings in S&E fields may not be a situation unique to S&E and/or Asian women. A study that examines U.S.-born minority women in all occupations (not just scientists and engineers) reveals similar results for Asian and other minority women. Greenman and Xie (2008) examine the interaction of gender and race on the earnings of U.S.-born workers in the U.S. They compare non-Hispanic white women with 18 groups of minority women (including mixed race), such as Chinese, Asian Indian, Korean, Cuban, Asian-white, Black-Asian, Filipino, Vietnamese, Black-white, Native American-white, Hispanic, Puerto Rican, Mexican, Black, Native American, other Asian, other Hispanic, and other women. They find that the gender difference in earnings of every minority group is smaller than that of whites. In other words, the gender penalty or the disadvantage of being women is smaller for minority women than that for white women. Thus, the "double penalty" is not an accurate description of minority women's economic status. The authors argue that, instead of minority women earning more than expected, white women earn less than expected. A possible explanation for this finding is that white families are more specialized, with women being more economically dependent on men, than other racial/ethnic groups, and white women are more likely to experience a linkage between gender inequality at work with gender inequality at home. The same explanation may apply to white and Asian scientists and engineers. White women scientists and engineers are likely underpaid, and thus, their earning gap with comparable white men is larger, although not statistically significant, than that among some Asian group. Comparisons within white women at both quantile points show that white women did not earn more than any Asian women's groups in 2003.

Structurally speaking, women are still at a disadvantage. Although Asian women do not suffer from the "double bind," U.S.-educated immigrant women earned less than their male counterparts in 2003. Also, white women and U.S.- and Asian-educated immigrant women earned less than comparable white males in 2003. Similar to those employed in female-dominated occupations and jobs, some women in male-dominated fields also suffer from earning disparities. It is likely that they are concentrated in lower-status positions, such as production and sales engineers, rather than in high-status positions, such as R&D engineers (McIlwee and Robinson 1995).

7.3 Field Differences

The findings in the previous chapter also reveal field differences. First, at the 50th quantile, the effect of degree origin did not disappear over time among engineers. However, it disappeared among computer scientists. Furthermore, compared with engineers, comparable computer scientists earned more in both years at both quantile points. Yet, although the earning differences between comparable computer scientists and engineers were significant, the differences were smaller than the internal differences among some groups, such as U.S.-educated immigrant men and women who were otherwise the same in 2003.

The relative better economic prospectus of computer scientists than engineers found in this study as well as both occupations' better prospectus than other occupations are consistent with the national compensation survey data conducted by the Bureau of Labor Statistics (2008). The wages for computer scientists and engineers are similar and about twice as much as national average for all occupations. In 1997 (the earliest year with available data on its website), the mean wage was $15.09 (in 1997 dollars) per hour for all occupations combined, $26.79 per hour for computer systems analysts and scientists, and $27.76 for engineers, architects, and surveyors (no independent category for only engineers). More detailed data show that among engineers, the hourly wage rate varied from $25.37 for mechanical engineers to $35.44 for petroleum engineers. In 2003, the national average was $17.75 (in 2003 dollars) for all occupations, $33.25 for computer systems analysts and scientists, and $34.24 for engineers, architects, and surveyors. More specifically, the wage varied from $30.22 for civil engineers to $46.77 for petroleum engineers.

Both the above findings may be related to the increasing demand for computer scientists and engineers in the U.S. from 1993 to 2003, with a larger demand for the former than the latter. NSB (2008) and some CPST reports show that in the past a few decades, S&E workforce grew to a larger extent than the general workforce in the U.S. Among S&E fields, the growth of computer-related jobs was the largest, and that of engineering positions was also considerable. From 1983 to 2002, the period that Babco and Ellis's (2004) report covers, the employment of computer systems analysts, scientists, programmers, and faculty (degree level not indicated) increased and peaked in 2000. The change from 1983 to 2000 was 250%. Among all the computer-related jobs, the increase of computer systems analysts and scientists was even larger—it increased by 665% from 1983 to 2001, when its number peaked. Compared with computer scientists in general, engineers had a smaller growth during the same time period. The engineering employment peaked in 2000, with an increase of 36%. Among all engineering subfields, electrical and electronic engineering witnessed a larger growth of 64% from 1983 to 2001, when its number peaked. For engineers, although reports also suggest a shortage, the impact of the perceived and actual shortage does not seem to have as great an impact as that on earnings for computer scientists. The difference in the degree of demand may explain the differences in earnings between computer scientists and engineers in both years, net of other factors.

The International Society of Automation's InTech magazine has addressed engineering workforce issues. Policastro (2008) reports that the salaries for engineers keep increasing, and the main reason is the increasing demand for engineers, especially experienced engineers. In computer science, the shortage of U.S.-born workers, and more specifically, women, has attracted attention from the community. Jepsen (2001) reports that in computer science, women are clearly underrepresented, especially among graduate degree recipients and faculty. The computer science community calls for more female faculty for role model purposes. He argues that if women in computer science increase their representation to the level of their general workforce representation, then the problem of shortage is almost solved.

Another article from the Bureau of Labor Statistics finds that the information technology (IT) industry has experienced increasing demand for workers over time, despite the offshoring of some IT work. Wright (2009) analyzes the employment trends of the following jobs defined as IT jobs, which are treated as computer scientists by NSF: computer and information research scientists, computer software engineers, database administrators, network and computer systems administrators, computer systems analysts, network systems and data communications, computer support specialists. Wright also includes computer hardware engineers, who are regarded as engineers by NSF, as well as computer programmers and computer and information systems managers, which are treated as non-computer scientists or engineers by NSF. Wright reports that in the 1990s, as technology became an increasingly important part of everyday life, the demand for IT services also grew. In 2001, IT employment declined but recovered soon and rose again in 2003. Some positions, such as systems administrators, information systems managers, computer software engineers experienced an employment increase by at least 22% from 2001 to 2007. Other positions, such as computer and network systems analysts and network systems and data communications analysts had increases in employment between 8% and 16% in the same time period. Some exceptions existed for programmers and computer support specialists that are susceptible to offshoring or automation (being automated rather than performed by workers).

Babco and Ellis (2006) report national data on salaries for all occupations and S&E occupations, all degrees combined. They find that from 1995 to 2005, the median salaries for all employed workers who were 16 years or older earned median salaries from $31,500 to $34,500 (all converted to constant 2005 dollars). For the same period, science, technology, engineering, and mathematics (STEM) workers combined earned median salaries from $53,000 to $58,000. Among all STEM occupations, the highest median salaries were found among computer scientists, who earned from $55,000 to $63,500 and among engineers, who earned from $61,500 and $65,500. NSB (2008) reports that from 1993 to 2003, the mean real salary for recent bachelor's degree recipients increased by about 15% across S&E fields but 23% in computer and mathematical sciences and 20% in engineering.

Factors that may influence earnings in computer science and engineering from 1993 to 2003, the period this study covers, include outsourcing, which started at a large scale in the late 1990s. A large number of technical jobs, such as programming, have been recently outsourced to countries where labor and other costs are cheaper than those in the U.S. As a result, unemployment rate in related fields has been higher. However, the impact of outsourcing has not been reflected in the sample since the data in the sample are for full-time workers. Furthermore, full-time positions in these fields that remain in the U.S. may be technically intensive and are not as easily outsourced as less technically-intensive positions, and as a result, these positions may not decrease payment when the outsourcing of other jobs is common. Note that programmers or technicians are not categorized as computer scientists or engineers in the NSF data set. Similarly, other factors, such as the telecom crisis in the 1990s and the dotcom bubble in the early 2000s, are not considered in this paper because they impacted employment more heavily than payment. In addition, studies have found that the dotcom bubble in the early 2000s heavily influenced a very small portion of IT firms—only those relying solely on the Internet were the focus of impact during the dotcom bubble (Panko 2008).

7.4. Sector Differences

In addition to fields, employment sectors also behave differently in rewarding their employees. This study finds that compared with industry as a whole, educational institutions and state/local government paid consistently lower. When compared with the three types of industry, namely, self-employment, for-profit firms, and non-profit organizations, educational institutions and state/local government still paid lower in each year at each quantile point. This is not surprising because these sectors have their own cultures, and workers choose a certain sector either for higher payment at the cost of less personal time or for more personal freedom in projects, more flexible time schedule, and/or job security at the cost of a better income. These cultures do not seem to have changed dramatically over time.

Federal government had a slightly different pattern from other employment sectors. It paid comparable computer scientists and engineers less than industry or self employment and for-profit firms in 1993 and 2003 at the 90th quantile. However, at the 50th quantile, it not only eliminated payment gap with industry in general and for-profit firms but also paid more than self-employment and non-profit organizations in 2003. yet, it was not true in the upper tail.

In short, the three employment sectors have different cultures and different patterns of rewarding comparable employees. As discussed earlier, in the educational institutions, Asian Americans earn more due to their race. Federal government, while eliminating its payment gap with or increasing its payment advantage over industry over time, it still paid the Asian-educated less due to their degree origin.

7.5 Nationality Differences

An earlier section in this chapter shows that some Asian-educated nationality groups earned less than comparable U.S.-educated computer scientists and engineers in 1993, but this effect disappeared in most cases in 2003. Further disaggregated analysis shows that this effect existed for a few but not all nationality groups.

Furthermore, compared with whites, some but not all nationality groups among U.S.- or Asian-educated immigrants experienced earning disadvantages. In addition, Asian immigrants had internal earning disparities in that among the U.S.- or the Asian-educated, some nationality groups earned less than Indians while others did not. Over time, the earning disparities with whites of U.S.-educated workers of all nationalities disappeared but those of Asian-educated workers of some nationalities persisted. Compared with their Indian counterparts, some U.S.-educated nationality groups eliminated the earning gaps but others started to have gaps over time.

The above findings may be accounted for by the status of these specific ethnicities in the U.S. and education in these countries. The socioeconomic status of certain Asian ethnicities in the U.S. may directly or indirectly influence the image or perceived personal qualifications of immigrants of the same ethnicities. For instance, in the U.S., fewer Japanese immigrated after 1965, when the immigrant law gave priorities to family reunion and skilled immigrants. Compared with other Asian ethnicities, including the Chinese and Koreans, the Japanese are more structurally assimilated in terms of achieving similar educational and occupational attainment as whites. Filipinos who came to the U.S. after 1965 tend to come to the U.S. to seek for better payment for their skills in various fields, such as medicine, than that in the Philippines. Among the Vietnamese in the U.S., a large proportion is refugees. Those who left Vietnam before 1975 were overall economically better off than the general Vietnamese population, but those who left after 1975 were in general poorer than earlier immigrants. In refugee camps, Vietnamese children received education in English and western etiquette but did not learn math, science, and other subjects for years. At home, 93% of the Vietnamese speak non-English. The Chinese, Koreans, and Asian Indians tend to be skilled workers who immigrated after 1965 (Xie and Goyette 2004). The socioeconomic status of the Asian ethnicities, especially the Japanese, Filipinos, the Vietnamese, and Indians may present an overall image of these ethnicities, including those recent, highly-educated immigrants. In addition, Sharpe and Abdel-Ghany (2006) report that while Asian Indians (not just scientists and engineers) have similar earnings to and Japanese workers earn more than their white counterparts, Chinese, Filipino, Korean, and Vietnamese workers earn less than comparable whites.

A more possible reason for the disparities of Asian-educated workers with whites is, as the region-specific human capital literature suggests, the economic status and the degree of the use of English in these nations (Bratsberg and Ragan 2002). Zeng and Xie (2004) report that compared with their U.S.-born, U.S.-educated white counterparts, U.S.-educated Asian immigrant workers (all workers, not just scientists and engineers) did not earn less but Asian-educated Asian immigrants of all ethnicities did except the Japanese, who earned more. The findings of this study confirm some of the findings in earlier studies. The reward to the highest degree obtained in a U.S. higher education institution is higher for immigrants from less-developed and/or non-English-speaking countries than those from more developed and/or English-speaking countries. China, Vietnam, and the Philippines are relatively less developed, and Asian-educated immigrants from these countries earned less than their U.S.-educated counterparts in both years. Asian-educated immigrants from these countries also earned less than their white counterparts in both years. Korea and Taiwan are more developed than the above three countries, but English is not their official language.

Japan is also economically advantaged, and Asian-educated Japanese immigrants are not disadvantaged when compared with their U.S.-educated or white counterparts. Indians fare better than most other groups, which may be partly explained by the fact that English is an official language there. The economic status of other countries, including Singapore, Thailand, Laos, etc. are quite different from each other, and the grouping of "Others" masks the differences between these countries. However, due to the small number of Asian-educated workers who were born in these countries, the grouping could make the analysis of other nationality groups, such as the Chinese and Indians, clearer.

The quantile regression also indicates that findings differ at different quantile points. The findings about the effects of race, nativity, degree origin, gender, and field reveal that more nationality groups of U.S.- and Asian-educated immigrants suffered from earning disadvantages at the median than in the upper tail. In other words, these effects or earning differences due to the above effects were less obvious at the 90th than at the 50th quantile. But for federal government, changes occurred over time at the median but not in the upper tail.

7.6 Theories Revisited

7.6.1 Structural Perspectives

The analyses suggest that the structural perspectives answer my research questions. This study finds that in terms of race, Asian American men earned less than their white counterparts in 1993 at .90 quantile, showing the white advantage in earnings in the upper tail among men. In terms of nativity, U.S.-educated immigrants earned less than their Asian American counterparts, which was evident in more cases at the median than in the upper tail. In terms of degree origin, again, its effect was evident in more cases at the median than in the upper tail. Most of the above effects disappeared in 2003, but others remained and some of them even increased, such as the effect of nativity in government at the median increased by 2%, and the effect of degree origin narrowed down among engineers but remained similar in educational institutions.

Furthermore, some Asian women's groups experienced earning disparities with their male and also with their white male counterparts. In addition, some sectors paid comparable workers more than others and the patterns did not change much over time. In short, the structure of science and engineering continue to place some groups, including Asians of different backgrounds and women, at a disadvantaged position.

The findings seem to suggest that Asians fare differently from other minorities when compared with their white counterparts in earnings, as suggested by previous studies. The most important or determining factor is likely the fact that these fields or occupations are well-paid rather than low-paid positions, which the job segregation literature has focused on. In addition, although Asians are overrepresented in computer science and engineering, these occupations are not segregated as predominantly Asian occupations. The fact that the dominant groups in these fields are still whites and men may explain the lack of earning disadvantages of minority workers (or some Asian groups in this case) due to race.

The finding that Asians, especially Asian Americans, did not fare worse than their white counterparts in most cases in 2003 seems to suggest that Asian race (or to a lesser degree, nativity and degree origin) is no longer a determining factor that leads to inequality. I urge readers to be careful in generalizing the finding. The failure of finding the effect of race could be due to the small numbers of Asian Americans in the sample. More importantly, earnings are just one aspect of labor market outcomes. In fact, previous studies have recorded the disadvantages of Asian scientists and engineers in the workplace. For instance, they are often passed over for management positions, and they are not trusted as members in the organization.

Feagin (2006) argues that while whites rationalize their racism, people of color across the globe are increasingly challenging their domination. While Asian immigrant computer scientists and engineers who received highest degrees in Asia were disadvantaged due to the systematic racism and other factors (*e.g.*, their human capital obtained in Asia), their experience changed over time. Of course, structural changes did not eliminate the earning disadvantages of U.S.- or Asian-educated immigrants in all cases. The disappearance of the negative effects of Asian degree origin could be, to a larger degree, due to structural changes rather than the challenge of people of color. The disappearance of their earning disadvantages could be due to changes in the U.S. S&E

workforce (e.g., a shortage of trained labor in computer science and engineering) and resulting policy changes. Teitelbaum (2003), Freeman (2004), and other scholars have analyzed the unattractiveness of these fields to U.S. citizens, and that the shortages of S&E workers have been filled by immigrants. The changes may lead to a decrease in systematic racism—recall that in the systematic racism theory, institutions, such as government, are an important source of racism. The other factor that may lead to the disappearance of the earning disadvantages of Asian-trained immigrant workers can be due to the improvement of their human capital. The last two points are further discussed in the following parts of this section.

Smith (2005) asserts that many structural theory studies do not form their theories based on empirical studies or test their theories against empirical data and thus remain speculative. This study tests structural theories through empirical analysis and argues that structures work not only by themselves through paying certain groups, such as women and some Asian groups, less than their men and white counterparts but also can change due to their interplay with human capital. The interplay is evidenced in the findings that the pay gap may change over time due to structural changes in higher education in Asia, public policies in the U.S., and rewarding structure in the U.S. workplace.

7.6.2 Region-Specific Human Capital

The results show that region-specific human capital did have an impact in 1993. However, its effect disappeared in 2003. The findings also confirm those of earlier studies that report the effects of the economic status of the nation and the use of English as the official language of the nation.

This study also finds that the effect of the human capital obtained in a region, Asia, on earnings does not remain unchanged. Apparently, the quality of the human capital obtained in Asia can change due to the improvement in the various aspects of higher education in the region. However, for certain nations in the region, with all the investment in education, improvement in the quality of education, and improvement in economic standing in the world, immigrants originally from these nations still experience an earning disadvantage. The findings suggest that while employers' perceptions towards human capital obtained in a world region change substantially enough to change the ways they reward immigrants from that region, their perceptions towards certain countries in the region—those with relatively low GDP and/or non-English-speaking countries—change more slowly. The former finding could be an aggregate result, but it does inform a change. The latter is more disaggregated. Looking at both the region and the country levels tells us more about the changes that the region, the nations, and the world have undertaken in the age of globalization.

Also, the mechanism that determines the return to education or to the human capital obtained in a certain region outside the host country can change over time. The next part discusses this change.

7.7 Model Minority Revisited

This study finds internal differences of Asian computer scientist and engineers due to nativity and degree origin, by gender, field, and sector, and among immigrants, by nationality. The results again confirm that in the U.S., not all Asians do as well as their white counterparts and that Asians have strong heterogeneity among themselves, *e.g.,* ethnic differences and gender differences. However, due to data limitation, this study does not examine the ethnic differences among Asian Americans. Nevertheless, the reported patterns among immigrants have provided disaggregated findings regarding the earning status of Asians with different backgrounds in the U.S.

CHAPTER 8

SUMMARIES, IMPLICATIONS, AND CONCLUSIONS

8.1 Summary

This study examines the earnings of full-time, college-educated Asian computer scientists and engineers in the U.S. More specifically, this study investigates the effects of race, nativity, degree origin, gender, field, and sector of all Asian computer scientists and engineers and that of the nationality of Asian-born immigrants. It finds that U.S.-born, U.S.-educated Asian American men earned less than their white counterparts at the 90th quantile in 1993, indicating a negative effect of Asian race, but it disappeared in 2003. Also, in 2003, Asian Americans earned more than whites in educational institutions at the 50th quantile. But this finding could be due to the small number of Asian Americans in educational institutions.

Asian-born, U.S.-educated Asian immigrants experienced earning disadvantages due to their nativity in educational institutions at the 90th quantile but among men, among engineers, in government, and in industry at the 50th quantile in 1993. The nativity effect disappeared in 2003 in all cases except in government, where it increased by 2%.

Asian-born, Asian-educated Asian immigrants suffered from earning disadvantages due to their degree origin. The degree origin effect existed among men, women, engineers, and in industry at the 90th quintile and, in addition, among computer scientists and in educational institutions at the 50th quantile in 1993. This effect disappeared in 2003 in all cases except among engineers and in educational institutions in the 50th quantile, where the effect narrowed down in the former and remained similarly in the latter. The effects of race, nativity, and degree origin are net effects, meaning that Asian-educated immigrants suffered from not only degree origin effect but also nativity and race effects, if any.

These results suggest that while Asian-educated immigrants earned less because Asian education was not valued as much as U.S. education in the U.S. workplace in 1993, the earning gap disappeared in most cases over time due to the improvement of Asian education, especially that in science, engineering, and English. In addition, changes in immigration policies could lead to a change in the earning status of highly-educated immigrant workers in well-paid occupations. Changes in immigration policies could also change U.S. employers' perceptions towards human capital with an Asian origin and recruit them in an effort of attracting all talent from the world.

A further examination of the national origins of the Asian-educated reveals that among the Asian-educated, not all nationality groups experience earning disadvantages due to their degree origin. More specifically, Asian-educated immigrants from China, Korea, Vietnam, and the Philippines earned significantly less than their U.S.-educated, white, and to a lesser degree, Indian counterparts. An important factor that can explain the disadvantages of these countries but not others is that compared with other Asian countries, these nations are either less developed or do not have English as an official language. The Japanese and the Taiwanese are not disadvantaged when compared with their U.S.-educated or white counterparts. Their economic standing could explain their earning status. In addition, the Japanese are more assimilated than other Asian ethnic groups in the American society. Asian-educated immigrants finally achieved earning parity with their U.S.-educated counterparts, but among them, those from some countries kept earning less than their U.S.-educated counterparts. This finding may be explained by the fact that employers' perceptions towards immigrant computer scientists and engineers from certain countries, which have relatively low GDP and/or do not speak English as an official language, change more slowly than those towards human capital obtained in a world region that has improved its education recently.

This study also finds gender differences within races. At the 90th quantile, in 1993, Asian-educated immigrant women, and in 2003, white and U.S.-educated immigrant women earned less than their male counterparts. Asian American women earned more than their male counterparts in 1993 but not in 2003. The earning advantage of Asian American women could be due to the small size of this group in 1993. However, the other women's groups suffered from their gender, which is consistent with the findings of the literature. But at the 50th quantile, white and Asian American women earned less than their male counterparts in 2003. In addition, one women's group suffered from the double bind effect. At the 50th quantile, in 1993, U.S.-educated women immigrants suffered from the double bind effect in earnings, which disappeared in 2003.

I reassert here that readers need to be careful in interpreting and generalizing the findings, especially those regarding the effect of Asian race or the status of Asian Americans. Asian race had an effect on earnings that existed in fewer cases than Asian nativity and degree origin. However, readers should not generalize this finding to the other aspects of career outcomes, such as promotion, or the general experience, such as being trusted as group members in the workplace. Earnings are just one aspect of the career outcomes, and although one Asian group may not earn less than comparable whites, it does not mean that the Asians are treated as fairly as the whites. For Asian American women, we may not generalize their lack of earning differences or even their earning advantage over their male counterparts in one case to the other aspects of their careers. Asian American women are a very small group in the samples of this study, and the small size could influence the findings.

In addition, this study finds field and sector differences. Computer scientists earned slightly more than engineers in both years. The demand and the shortage of S&E workers were high in engineering, and they were even higher in computer sciences. The higher demand in computer sciences could account for the higher salaries of computer scientists than their engineer counterparts. Furthermore, among engineers, the effect of degree origin narrowed but did not disappear over time. In terms of sector differences, those in industry earned consistently more than those employed in educational institutions and state/local governments, but the advantage of industry over federal government disappeared over time at the 50th quantile (but not the 90th).

The findings partly confirm the structural argument that some minority groups suffer in the society and the workplace due to their nativity, gender, sector, and national origin. The findings also support the region-specific human capital theory but find that its effect can change. The change of the effect of human capital has to be placed in a context of globalization and the resulting structural changes in various aspects, including the improvement in higher education in Asia and changes in immigration policies in the host country, the U.S.

The above findings also suggest that, overall, the factors that are examined in this study had more evidence at the 50the quantile than at the 90th. In other words, these factors had less effect than in the upper tail than at the median. Workers at the 90th quantile of the earnings were less influenced by their personal and employment characteristics, including race, nativity, degree origin, gender, field, sector, and nationality.

8.2 Policy and Research Implications

8.2.1 Policy Implications

This study investigates an aspect of the career advancement—earnings—of a group who have traditionally overrepresented in computer science and engineering in the U.S. It finds that while Asian race, nativity, and degree origin had negative effects on earnings in 1993, they disappeared with exceptions in 2003 due to structural changes. The structural change on the U.S. side was the changes in immigration policies. More Specifically, more employment-based visas were issued in an effort of recruiting foreign talents. Some scholars are concerned that the employment of non-U.S. citizens in some S&E fields would decrease the earning level of the whole field. Thus, to solve earning disparities and keeping salaries to a proper level for workers of all backgrounds are important to retaining the attractiveness of the field to all talent. This is especially true in the context of a current or a looming shortage of science and engineering workers. Furthermore, the exceptions, such as government and educational institutions, where U.S.-educated and Asian-educated workers did not eliminate earning disadvantages due to their nativity and degree origin, respectively, also need to work on solving the earning disparities.

Some studies show that globalization makes it harder for the U.S. to attract foreign talent, and competition for IT talent is global. Not only do western countries are competing for talent globally, but also some developing countries, such as India and China, the major sources of immigrant scientists and engineers, are attracting more of their own to come back or stay in their own countries (West and Bogumil 2001). The lesson for the U.S. is that a better mechanism should be in place to continue to welcome and facilitate the coming of foreign talents, including the foreign-trained, as well as attracting and retaining more U.S. citizens of all races/ethnicities. This mechanism that aims at attracting talent from the world can include a better visa system and a better way to evaluate and reward workers of all backgrounds.

In addition, some women's groups remained earning less than their male and white male counterparts. Not only some Asian women's groups but also white women earned less than comparable white men. The gender gap in earnings and other aspects of careers have been long in existence and have not improved much over time. For instance, while women of all races/ethnicities receiving S&E degrees have increased their numbers and shares in the past a few decades, the percentage of women of any race/ethnicity did not increase much. Furthermore, women continue to earn less than their male and/or white male counterparts. Policies should focus on solving the gender disparities in earnings and other aspects and create a more welcoming environment to potential women scientists and engineers who would otherwise go to other fields. A more welcoming environment is also helpful in fostering and improving the diversity of the S&E workforce. An S&E workforce that is diverse in race, gender, and culture is essential to the competitiveness and the healthy growth of the science and technology development in a nation.

In some Asian countries, policies can be made to improve the quality of education and increase the competitiveness of their graduates in the world labor market as well as their own. The findings of this study suggests that the improvement in the human capital obtained in Asia was associated with the improvement in earnings of workers who received their highest degrees from Asian higher education institutions. The improvement in English and S&E education as well as the structural reforms in educational systems were related to the change. The further improvement in these aspects as well as others, such as research capacities in S&E, could help these countries better to improve their educational qualities and also train their graduates to be more competitive.

8.2.2 Limitations of the Study and Research Implications

This study has several limitations. First, the size of Asian Americans and Asian-educated workers, especially when they are disaggregated, is quite small. The small size of the groups, especially Asian Americans, could influence the findings regarding them. Second, due to the limitation of data, this study does not investigate the effects of ethnicities of Asian Americans on earnings and the internal earning differences of Asian Americans by ethnicity. Third, also due to the limitation of the database, this study does not disaggregate computer scientists or engineers by more detailed jobs, such as computer and information scientists, computer support specialists, computer systems analysts, or database administrators.

On the other hand, this study has set the foundation for many future studies. It finds the disadvantages of the U.S.- and Asian-educated in most cases due to their nativity and degree origin, respectively, but U.S.-born, U.S.-educated Asian Americans did not earn less due to their race in most cases. This finding could be due to the small number of Asian Americans in the samples. To better understand how they fare in earnings and other aspects of their careers, future research can conduct surveys that cover more Asian Americans and employ in-depth interviews.

This study examines the earnings of workers who were employed full time. It does not investigate other aspects of career attainment that may be specific to women, such as the type of employment (full-time, part-time, or not working) to balance work-family responsibilities. Previous studies have found that women are more likely than men to work part-time or out of work. This may or may not be true for some minorities groups. Furthermore, this study does not fully examine the underemployment of immigrant computer scientists and engineers. The underemployment may be the result of choosing to stay and work in the U.S. But the underemployment and the resulting underpayment could also be due to their segregation into certain tasks that are paid less than others even when these positions share the same job title as a computer scientist or an engineer. Future studies based on interviews can examine the issues regarding employment.

In addition, globalization has an impact on the fields of computer science and engineering, which have experienced offshoring recently. Future research can examine the influence of offshoring on the career advancement of scientists and engineers with different personal characteristics in the U.S. Future research can also compare computer scientists and engineers with workers in less technically-intensive fields to see how large the effects of offshoring are to scientific and technical fields.

Furthermore, the readers do not know yet whether the above patterns will continue at the time of economic downturn. At such time, Asians, especially Asian women, may have higher unemployment rates than whites. Future research can examine the impact of economic changes on the earnings and other aspects of the career advancement, such as retention and promotion of Asians or other minorities.

Other long-term research projects include tracking the flow of U.S.-educated Asian immigrants back to Asia and their career advancement, compared with their U.S.- or Asian-educated and -employed counterparts. Recently, more and more Asian and other scientists and engineers trained in the U.S. teach and/or conduct scientific research in Asia, and one country that has witnessed the rapid change is China. Few sociological studies examine these trends and their impact on the career attainment of these scientists and engineers.

This study has provided disaggregated findings about an understudied group, Asian scientists and engineers. In addition, this study also confirms the heterogeneity of women and a minority group. The findings of this study again shows that women and Asians are different from each other. Thus, future studies should continue to investigate the intersection of race and gender.

REFERENCES

Alessio, John C. and Julie Andrzejewski. 2000. "Unveiling the Hidden Glass Ceiling: An Analysis of the Cohort Effect Claim." *American Sociological Review* 65(2):311-315.

Altbach, Philip G. and Toru Umakoshi. 2004. *Asian Universities: Historical Perspectives and Contemporary Challenges*. Baltimore, MD: The Johns Hopkins University Press.

Babco, Eleanor and Richard Ellis. 2004. "Twenty Years of Scientific and Technical Employment." *Commission on Professionals in Science and Technology*. Retrieved November 1, 2007 (http://www.cpst.org/)

------. 2006. "Science and Technology Salaries: Trends and Details, 1995-2005." Commission on Professionals in Science and Technology. Retrieved November 1, 2007 (http://www.cpst.org/).

Baron, James N. and William T. Bielby. 1980. "Bringing the firms back in: Stratification, segmentation, and the organization of work." *American Sociological Review* 45: 737-765.

Barringer, Herbert R., David T. Takeuchi, and Peter Xenos. 1990. "Education, Occupational Prestige, and Income of Asian Americans." *Sociology of Education*, 63(1):27-43.

Becker, Gary S. 1993. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* (3rd ed). Chicago: University Of Chicago Press.

------. 2002. "The Age of Human Capital." Pp. 3-8 in *Education in the Twenty-First Century,* edited by E. P. Lazear. Stanford, CA: Hoover Institution Press.

Birmingham, Stacy G. and Mara H. Wasburn. 2008. "On or off the Tenure Track: the Work Lives of Women Engineering and Technology Faculty." *Journal of Women and Minorities in Science and Engineering* 14(4): 411–425.

Blalock, Hubert M. 1967. *Toward a Theory of Minority-Group Relations*. New York: John Wiley & Sons, Inc.

Blundell, Richard L., Lorraine Dearden, Costa Meghir, and Barbara Sianesi. 1999. “Human Capital Investment: The Returns from Education and Training to the Individual, the Firm and the Economy.” *Fiscal Studies* 20(1):1–23.

Boudon, Raymond. 1971. *The Uses of Structuralism*. London: Heinemann Educational Books.

Bourdieu, Pierre. 1985. The Forms of Capital. pp. 241-58 in *Handbook of Theory and Research for the Sociology of Education,* edited by J. G. Richardson. New York: Greenwood.

Bozeman, Barry. 2004. “Editor’s Introduction: Building and Deploying Scientific and Technical Human Capital.” *Research Policy* 33:565–568.

Bratsberg, Bernt, and James F. Ragan, Jr. 2002. “The Impact of Host-Country Schooling on Earnings - A Study of Male Immigrants in the United States.” *Journal of Human Resources* 37(1):63-105.

Brown, A Ramona, Carole Morning, and Charles Watkins. 2005. “Influence of African American Engineering Student Perceptions of Campus Climate on Graduation Rates.” *Journal of Engineering Education* 94(2):263-271.

Brown, Susan. 2008. “The Gender Diffeernces: Hispanic Females and males Majoring in Science or Engineering.” *Journal of Women and Minorities in Science and Engineering* 14(2):205-223.

Browne, Irene and Joya Misra. 2003. “The Intersection of Gender and Race in the Labor Market.” *Annual Review of Sociology* 29: 487-513.

Bureau of Labor Statistics. 2008. http://data.bls.gov/PDQ/outside.jsp?survey=nc; http://www.bls.gov/oco/ocos042.htm (Computer Scientists); http://www.bls.gov/oco/ocos027.htm#earnings (Engineers)

Burrelli, Joan, S. 2006. “Academic Institutions of Minority Faculty with S&E Doctorates.” *National Science Foundation Info Brief*. Retrieved December 09, 2008 (http://www.nsf.gov/statistics/infbrief/nsf06318/).

Burt, Ronald S. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard Univ. Press

Cao, Cong. 2002. "Strengthening China through Science and Education: China's Development Strategy toward the Twenty-First Century." *Issues and Studies*, 38(3):122-149.

China.org.cn. 2009. Data on the population of China in 2003. Retrieved March 13, 2009 (http://www.china.org.cn/english/features/China2004/106477.htm).

Chiswick, Barry R. 1983. "An Analysis of the Earnings and Employment of Asian-American Men." *Journal of Labor Economics* 1(2):197-214.

Chou, Rosalind and Joe R. Feagin. 2008. *The Myth of the Model Minority: Asian Americans Facing Racism*. Boulder, CO: Paradigm Books.

Clark, Larry. 2005. "Strength in Diversity." *Oceanography* 18(1):6-7.

Cole, Jonathan. 1979. *Fair Science*: Women in the Scientific Community. New York: Free Press

Cole, Jonathan and Steven Cole. 1973. *Social Stratification in Science*. Chicago: The University of Chicago Press.

Cole, Jonathan R. and Harriet Zuckerman. 1984. "The Productivity Puzzle: Persistence and Change in Patterns of Publication among Men and Women Scientists." *Advances in Motivation and Achievement* 2: 217-258.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *The American Journal of Sociology* Supplement: Organizations and Institutions: Sociological and Economic Approaches to the Analysis of Social Structure 94: S95-S120.

Commission on Professionals in Science and Technology (CPST). 2004. "Women in Science and Technology: the Sisyphean Challenge of Change." Retrieved November 1, 2007 (http://www.cpst.org/).

------. 2006. “Four Decades of STEM Degrees, 1966-2004: ‘The Devil is in the Details.’” Retrieved November 1, 2007 (http://www.cpst.org/).

Committee on Science, Engineering, and Public Policy (COSEPUP). 2007. *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*. Washington D.C.: The National Academies Press.

Cookson, Clive. 2005. “Academia Seeks to Join Global Elite.” *Financial Times* 8 July: 9.

Cummings, William K. 1995. “The Asian Human Resource Approach in Global Perspective.” *Journal Oxford Review of Education* 21(1):67–81.

Daneshvary, N. 1993. “Earning differentials between Natives and Immigrants with College Degree.” *American Economist* 37(2):46-52.

Dobbin, Frank, Beth Simmons, and Geoffrey Garrett. 2007. “The Global Diffusion of Public Policies: Social Construction, Coercion, Competition, or Learning?” *Annual Review of Sociology* 33:449-72.

Ellis, Richard and B. Lindsay Lowell. 1999. “Foreign-Origin Persons in the U.S. Information Technology Workforce.” Retrieved November 1, 2007 (http://www.cpst.org/).

England, Paula. 1992. *Comparable Worth: Theories and Evidence*. New York: Aldine de Gruyter.

England, Paula. 2006. “Devaluation and the Pay of Comparable Male and Female Occupations.” Pp. 352-356 in *The Inequality Reader: Contemporary and Foundational Readings in Race, Class, and Gender,* edited by D. B. Grusky and S. Szelenyi. Boulder, CO: Westview.

England, Paula, Paul Allison, and Yuxiao Wu. 2007. “Does Feminization Lower Wages, Do Declines in Wages Cause Feminization, and How Can We Tell From Longitudinal Data?” *Social Science Research* 36:1237-1256.

Espenshade, Thomas J., Margaret L. Usdansky, and Chang Y. Chung. 2001. “Employment and Earnings of Foreign-born Scientists and Engineers.” *Population Research and Policy Review* 20(1-2):81-105.

Etzkowitz, Henry, Carol Kemelgor, Michael Neuschatz, and Brian Uzzi. 1994. "Barriers to Women in Academic Science and Engineering." Pp. 43 - 67 in *Who Wll Do Science? Educating the Next Generation,* edited by W. Pearson, Jr. and A. Fechter. Baltimore, MD: the Johns Hopkins University Press.

Etzkowitz, Henry, Carol Kemelgor, and Brian Uzzi. 2000. *Athena Unbound: The Advancement of Women in Science and Technology*. Cambridge: Cambridge University Press.

Fassinger, Ruth, Julie Arseneau, Jill Paquin, Heather Walton, and Judy Giordan. 2007. "It's Elemental: Enhancing Career Success for Women in the Chemical Industry." Retrieved Jun. 14, 2008 from (http://www.education.umd.edu/EDCP/enhance_site/It's%20Elemental.pdf).

Feagin, Joe R. 2006. *Systemic Racism: A Theory of Oppression*. New York: Routledge.

Fechter, Alan and Michael S. Teitelbaum. 1997. "A Fresh Approach to Immigration." *Issues in Science & Technology* Spring.

Finn, Michael. 2007. "Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2005." Retrieved November 03, 2007 (http://orise.orau.gov/sep/files/stayrate07.pdf).

Freeman, Richard. 2004. "Stimulating Careers in Science and Engineering: Science Next Wave?" *Science* 7 May. Retrieved May 2005 (http://sciencecareers.sciencemag.org/career_development/previous_issues/articles/3010/stimulating_careers_in_science_and_engineering).

Frehill, Lisa 2007. "A Look at Minorities in the Life Sciences." *AWIS Magazine* Spring: 19.

Frehill, Lisa and Nicole Di Fabio 2007. "Women's Representation in Mathematics." *AWIS Magazine* Summer: 21.

Fox, Mary Frank. 2001. "Women, Science, and Academia: Graduate Education and Careers." *Gender and Society* 15(5):654-666.

Fox, Mary Frank and Sushanta Mohapatra. 2007. "Social-Organizational Characteristics of Work and Publication Productivity among Academic Scientists in Doctoral-Granting Departments." *The Journal of Higher Education* 78(5):542-571.

Friedman, Thomas L. 2005. *The World is Flat.* New York: Farrar, Straus and Gioux.

Gaston, Jerry. 1973. *Originality and Competition in Science: A Study of the British High Energy Physics Community*. Chicago: University of Chicago Press.

Gatchair, Sonia Denise. 2007. "Representation and Reward in High Technology Industries and Occupations: The Influence of Race and Ethnicity." Ph.D. Dissertation, School of Public Policy, Georgia Institute of Technology, Atlanta, GA.

Gereffi, Gary and Vivek Wadhwa. 2005. "Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India." Retrieved Jun. 14, 2006 (http://www.soc.duke.edu/resources/public_sociology/duke_outsourcing.pdf).

Gereffi, Gary, Vivek Wadhwa, Ben Rissing, and Ryan Ong. 2008. "Getting the Numbers Right: International Engineering Education in the United States, China, and India." *Journal of Engineering Education* 97(1):13-25.

Glanz, James. 2000. "Racism Deters Asian American Scientists." *The New York Times*, July 16. Retrieved Jun. 14, 2008 from (http://modelminority.com/modules.php?name=News&file=article&sid=62)

Granovetter, Mark S. 1974. *Getting a Job: A Study of Contacts and Careers*. Cambridge, MA: Harvard University Press.

Grant, Linda, Ivy Kennelly, and Kathryn Ward. 2000. "Revisiting the Gender, Marriage, and Parenthood Puzzle in Scientific Careers." *Women's Studies Quarterly* 1–2. 28:62-85.

Greenman, Emily and Yu Xie. 2008. "Double Jeopardy? The Interaction of Gender and Race on Earnings in the United States." *Social Forces* 86(3):1217-1244.

Hanson, Sandra. 2004. “African American Women in Science: Experiences from High School through the Post-Secondary Years and Beyond.” *NWSA Journal* 16(3):240-248.

Harding, Sandra. 1991. *Whose Science? Whose Knowledge? Thinking from Women's Lives*. Ithaca, NY: Cornell University Press.

Heylin, Michael. 2008. “Academic Salaries.” *Chemical & Engineering News* 86(28):41-43.

Hirschman, Charles and Morrison G. Wong. 1984. “Socioeconomic Gains of Asian Americans, Blacks, and Hispanics: 1960-1976.” *American Journal of Sociology* 90(3):584-607.

Homans, George C. 1975. “What Do We Mean by Social ‘Structure?’” Pp. 53 ‑ 65 in *Approaches to the Study of Social Structure*, edited by P. M. Blau. New York: The Free Press.

Iceland, John. 1999. “Earnings Returns to Occupational Status: Are Asian Americans Disadvantaged?” *Social Science Research* 28: 45-65.

Jayaram, N. 2004. “Higher Education in India: Massification and Change.” Pp. 85-112 in *Asian Universities: Historical Perspectives and Contemporary Challenges*, edited by P. G. Altbach and T. Umakoshi. Baltimore, MD: The Johns Hopkins University Press.

Jepsen, Tom. 2001. “Women in IT: is the pipeline still shrinking?” *IT Professional* September/October:69-72.

Johnson, Angela C. 2007a. “Graduating Underrepresented African American, Latino, and American Indian Students in Science.” *Journal of Women and Minorities in Science and Engineering* 13(1):1-21.

------. 2007b. “Unintended Consequences: How Science Professors Discourage Women of Color.” *Science Education* 91:805-821.

Kaufman, Robert. 2002. “Assessing Alternative Perspectives on Race and Sex Employment Segregation.” *American Sociological Review* 67:547-572.

Kilbourne, Barbara, Paula England, George Farkas, Kurt Beron, and Dorothea Weir. "Returns to Skills, Compensating Differentials, and Gender Bias: Effects of Occupational Characteristics on the Wages of White Women and Men." *American Journal of Sociology* 100: 689-719.

Kim, Kyung Hee. 2005. "Learning From Each Other: Creativity in East Asian and American Education." *Creativity Research Journal* 17(4):337-347.

Kmec, Julie A. 2003. "Minority Job Concentration and Wages." *Social Problems* 50(1):38–59.

Kobitzsch, Werner, Dieter Rombach, and Raimund L. Feldmann. 2001. "Outsourcing in India." *IEEE Software* 18(2):78-86.

Krahn, Harvey, Tracey Derwing, Marlene Mulder, and Lori Wilkinson. 2000. "Educated and Unemployed: Refugee Integration into the Canadian Labour Market." *Journal of International Migration and Integration* 1:59–84.

Lal, Bhavya, Sam Yoon, Ken, Carlson. 1999. "How Large is the Gap in Salaries of Male and Female Engineers?" *NSF SRS Issue Brief*. Retrieved November 1, 2007 (http://www.nsf.gov/statistics/issuebrf/sib99352.htm).

Lam, Agnes. 2002. "English in Education in China: Policy Changes and Learners' Experiences." *World Englishes* 21(2):245-56.

Leahey, Erin. 2006. "Gender Differences in Productivity: Research Specialization as a Missing Link." *Gender & Society* 20(6):754.

Leahey, Erin, Jason L. Crockett, and Laura A. Hunter. 2008. "Gendered Academic Careers: Specializing for Success? *Social Forces* 86(3):1273-1310.

Lee, Myoung-Jin. 1993. "Asian-born Scientists and Engineers: Their Immigration Flow and Labor Market Adjustment." *Korea Journal of Population and Development* 22(1):69-88.

Leicht, Kevin T. 2008. "Broken Down by Race and Gender? Sociological Explanations of New Sources of Earnings Inequality." *Annual Review of Sociology* 34: 237-255.

Leggon, Cheryl B. 2006. "Women in Science: Racial and Ethnic Differences and the Differences They Make." *The Journal of Technology Transfer* 31(3):325-333.

Lewin, Keith M. 1987. "Science Education in China: Transformation and Change in the 1980s." *Comparative Education Review* 31(3):419-441.

Li, Hengde and Tieyong Zuo. 1995. "A Perspective of Materials Science and Engineering Education in China." *Materials Science and Engineering* 199(1):9-14.

Li, Peter. 1988. *Ethnic Inequality in a Class Society*. Toronto: Wall and Thompson.

Long, J. Scott and Mary Frank Fox. 1995. "Scientific Careers: Universalism and Particularism." *Annual Review of Sociology* 21:45-71.

Long, J. Scott, ed. 2001. *From Scarcity to Visibility: Gender Differences in the Careers of Doctoral Scientists and Engineers*. Washington, D.C.: National Academies Press.

Lowell, Lindsay. 2004. "Immigrants in Information Technology before and after the Bubble." Pp. 74-85 in *Education and Employment in Science and Engineering: A Global Perspective. Proceedings of an NSF/CPST/Professional Societies Workshop*, edited by N. E. Bell. Washington, D.C.: Commission on Professionals in Science and Technology.

Lozier, M. Susan. 2005. "A Community Effort toward the Retention of Women in Physical Oceanography." *Oceanography* 18:1.

Mahtani, Minelle. 2004. "Mapping Race and Gender in the Academy: The Experiences of Women of Colour Faculty and Graduate Students in Britain, the US and Canada." *Journal of Geography in Higher Education* 28(1):91-99.

Malcom, Shirley, Paula Hall, and Janet Brown. 1976. *The Double Bind: The Price of Being a Minority Woman in Science*. Washington, DC: American Association for the Advancement of Science.

Matthews, Christine M. 2008. "CRS Report for Congress: Foreign Science and Engineering Presence in U.S. Institutions and the Labor Force." Retrieved May 1 2009 (http://www.fas.org/sgp/crs/misc/97-746.pdf).

McIlwee, Judith Samsom and J. Gregg Robinson. 1992. *Women in Engineering: Gender, Power, and Workplace Culture*. New York: State University of New York Press.

Merton, Robert, K. 1978. *The Sociology of Science: Theoretical and Empirical Investigations.* Edited by Norman Storer. Chicago: University of Chicago Press.

Min, Weifang. 2004. "Chinese Higher education: the Legacy of the Past and the Context of the Future." Pp. 53-84 in *Asian Universities: Historical Perspectives and Contemporary Challenges*, edited by P. G. Altbach and T. Umakoshi. Baltimore, MD: The Johns Hopkins University Press.

MIT Report. 1999. *A Study on the Status of Women Faculty in Science at MIT.* Retrieved January 19 2009 (http://web.mit.edu/fnl/women/women.html).

------. 2002. *The Status of Women Faculty at MIT: An Overview of Reports from the Schools of Architecture and Planning; Engineering; Humanities, Arts, and Social Sciences; and the Sloan School of Management*. Retrieved January 19 2009 (http://web.mit.edu/faculty/reports/pdf/overview.pdf).

Mervis, Jeffrey. 2005. "A Glass Ceiling for Asian Scientists?" *Science* 310(5748):606 – 607. 28 October.

Miller, Susan Katz. 1992. "Asian-Americans Bump Against Glass Ceilings." *Science* 5085:1224-1225+1228.

Mooney, Paul and Shailaja Neelakantan. 2006. "Foreign Academics Question the Quality of Their Countries' Engineering Programs." *Chronicle of Higher Education* 53(3):24.

Morgan Lauren. 1998. "Glass-Ceiling Effect or Cohort Effect? A Longitudinal Study of the Gender Earnings Gap for Engineers, 1982 to 1989." *American Sociological Review* 63(44):479-493.

National Research Council (NRC). 2001. *Building a Workforce for the Information Economy*. Washington, D.C.: National Academies Press.

------. 2006. *To Recruit and Advance: Women Students and Faculty in Science and Engineering.* Washington, D.C.: National Academies Press.

National Science Board (NSB). 2008. *Science and Engineering Indicators 2008*. Two Volumes. Arlington, VA: National Science Foundation (volume 1, NSB 08-01; volume 2, NSB 08-01A).

National Science Foundation. 1999. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998.* Arlington, VA. (NSF 99-338).

------. 2003. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2000*. Arlington, VA (NSF 00-327).

------. 2006. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2003.*

------. 2008. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2006.*

National Science Foundation, WebCaspar database. (http://webcaspar.nsf.gov/).

nationsencyclopedia.com. 2009. Data on the population of India in 2003. Retrieved March 13, 2009 (http://www.nationsencyclopedia.com/Asia-and-Oceania/India-POPULATION.html).

Nettles, Michael T. and Catherine M. Millett. 2006. *The Three Magic Letters: Getting to PhD.* Baltimore, Md.: Johns Hopkins University Press.

Nunan, David. 2003. "The Impact of English as a Global Language on Educational Policies and Practices in the Asia-Pacific Region." *TESOL Quarterly* 37(4):589-613.

Padavic, Irene and Barbara Reskin. 2002. *Women and Men at Work*. 2nd ed. Thousand Oaks, CA: Pine Forge Press.

Panko, Raymond R. 2008. "IT Employment Prospects: Beyond the Dotcom Bubble." *European Journal of Information Systems* 17:182–197.

Pearson, Willie Jr. 1985. *Black Scientists, White Society, and Colorless Science: A Study of Universalism in American Science.* Millwood, N.Y.: Associated Faculty Press.

------. 2005. *Beyond Small Numbers: Voices of African American Ph.D. Chemists.* Elsevier.

Pennington, Martha C., Sufumi So, Keiko Hirose, Vrginia Costa, Joe Li Wai Shing, and Krystyna Niedzielski. 1997. "The Teaching of English-as-a-Second-Language Writing in the Asia-Pacific Region: a Cross-Country Comparison." *RELC Journal* 28(1):120-143.

Policastro, Ellen Fussell. 2008. "Salaries, Demand up for Engineers." *InTech* 55(4):69-70.

Portes, Alejandro. 1988. "Social Capital: Its Origins and Applications in Modern Sociology." *Annual Review of Sociology* 24:1-24.

Prokos, Anastasia H. and Irene Padavic. 2005. "An Examination of Competing Explanations for the Pay Gap among Scientists and Engineers." *Gender & Society* 19(4):523-543.

Raber, Linda R. 2007. "Small Increase in Women Faculty." *Chemical & Engineering News* 85(52):44-46.

Rashid, Rick. 2008. "Inspiring a New Generation of Computer Scientists." *Communications of the ACM* 51(7):33-34.

Reid, Lori L. 1998. "Devaluing Women and Minorities: The Effects of Race/Ethnic and Sex Composition of Occupations on Wage Levels." *Work and Occupations* 25: 511-536.

Reskin, Barbara F. 1980. "Fair Science: A Fair Test?" Review essay on *Fair Science* by Jonathan R. Cole and Stephen Cole. *Contemporary Sociology* 9:793-795.

Reskin, Barbara F. and Patricia A. Roos. 1990. *Job Queues, Gender Queues: Explaining Women's Inroads into Male Occupations*. Philadelphia: Temple University Press.

Reskin, Barbara F., Debra B McBrier, Julie A. Kmec. 1999. "The determinants and consequences of workplace sex and race composition." *Annual Review of Sociology* 25:335-361.

Rosser, Sue V. 2004. *The Science Glass Ceiling: Academic Women Scientists and the Struggle to Succeed.* New York: Routledge.

Ryabov, Igor and Patricia D. Witherspoon. 2008. "Diverse Pathways to the Ph.D.: A Study of Women Faculty in the Sciences and Engineering at a Hispanic-Serving Institution." *Journal of Women and Minorities in Science and Engineering* 14(3):319-337.

Saxenian, Annalee. 2006. *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, MA: Harvard University Press.

Schultz, Theodore W. 1961. "Investment in Human Capital." *The American Economic Review* 51(1):1-17.

Sharpe, Deanna L., and Mohamed Abdel-Ghany. 2006. "Determinants of Income Differentials: Comparing Asians with Whites and Blacks." *Journal of Family and Economic Issues* 27:588-600.

Simard, Caroline, Andrea Henderson, Shannon K. Gilmartin, Londa Schiebinger, and Telle Whitney. 2008. "Climbing the Technical Ladder: Obstacles and Solutions for Mid-Level Women." Anita Borg Institute for Women and Technology. Retrieved October 18 2009 (http://anitaborg.org/files/Climbing_the_Technical_Ladder.pdf).

Sinlarat, Paitoon. 2004. "Thai Universities: Past, Present, and Future." Pp. 201-220 in *Asian Universities: Historical Perspectives and Contemporary Challenges*. Baltimore, MD: The Johns Hopkins University Press.

Smith, Robert B. 2005. "Social Structural Inquiries, Part 1, Qualitative and Quantitative Theories." *Quality & Quantity* 39:801-825.

Smith-Doerr, Laurel. 2004. "Flexibility and Fairness: Effects of the Network Form of Organization on Gender Equity in Life Science Careers." *Sociological Perspectives* 47(1):25–54.

Sonnert, Gerhard. 1995. *Gender Differences in Science Careers: the Project Access Study*. With the assistance of Gerald J. Holton. New Brunswick, NJ: Rutgers University Press.

Stephan, Paula E. and Sharon G. Levin. 2001. "Exceptional Contributions to US Science by Foreign Born and Foreign Educated." *Population Research and Policy Review*, 20:1-2.

Tan, Jason. 2004. "Singapore: Small Nation, Big Plans." Pp. 175-200 in *Asian Universities: Historical Perspectives and Contemporary Challenges*. Baltimore, MD: The Johns Hopkins University Press.

Tang, Joyce. 1997. "Evidence for and against the 'Double Penalty' Thesis in the Science and Engineering Fields." *Population Research and Policy Review*. 16, 4: 337-362.

Tang, Joyce. 2000. *Doing Engineering: The Career Attainment and Mobility of Caucasian, Black, and Asian-American Engineers*. New York: Rowman and Littlefield Publishers.

Taylor, Valerie. 2002. "Women of Color in Computing." *SIGCSE Bulletin* 34(2):22-23.

Teitelbaum, Michael S. 2003. "Do We Need More Scientists?" Retrieved May 1, 2009 (http://www.sloan.org/assets/files/teitelbaum/publicinterestteitelbaum2003.pdf).

Torres Stone, Rosalie A., Bandana Purkayastha, and Terceira A. Berdahl. 2006. "Beyond Asian Americans: Examining Conditions and Mechanisms of Earnings Inequality for Filipina and Asian Indian Women." *Sociological Perspectives* 49(20:261-281.

Thurow, Lester C. 1975. *Generating Inequality: Mechanisms of Distribution in the U.S. Economy.* New York: Basic Books, Inc.

Tsapogas, John. 2005. "Recent Engineering and Computer Science Graduates Continue to Earn the Highest Salaries." *National Science Foundation Info Brief*.

Varma, Roli. 2006. *Harbingers of Global Change: India's Techno-Immigrants in the United States.* Maryland: Lexington Books.

Vogt, Christina M., Dennis Hocevar, and Linda Serra Hagedorn.2007. "A Social Cognitive Construct Validation: Determining Women and Men's Success in Engineering Programs." *The Journal of Higher Education* 78(3):337-364.

Wang, Wenjin, Jiayi Wang, Guizing Zhang, Yong Lang, and Victor J. Mayer. 1996. "Science Education in the People's Republic of China." *Science Education* 80(2):203-222.

Waters, Alan and Ma. Luz C. Vilches. 2008. "Factors Affecting ELT Reforms: The Case of the Philippines Basic Education Curriculum." *RELC Journal* 39(1):5-24.

Wentling, Rose Mary and Cristina Camacho. 2008. "Women Engineers: Factors and Obstacles Related to the Pursuit of a Degree in Engineering." *Journal of Women and Minorities in Science and Engineering* 14(1):83–118.

West, Lawrence A. and Walter A. Bogumil. 2001. "Immigration and the Global IT Workforce." *Communications of the ACM* 44(7):34-38.

Whitaker, Shree. 2001. "Underrepresented Minorities in Science: Double Jeopardy." *Science*, 2 March. Retrieved March 1, 2008 (http://sciencecareers.sciencemag.org/career_development/previous_issues/articles/0840/underrepresented_minorities_in_science_double_jeopardy)

Whitten, Barbara L., Shannon R. Dorato, Margaret L. Duncombe, Patricia E. Allen, Cynthia A. Blaha, Heather Z. Butler, Kimberly A. Shaw, Beverley A. P. Taylor, and Barbara A. Williams. 2007. "What Works for Women in Undergraduate Physics and What We Can Learn from Women's Colleges." *Journal of Women and Minorities in Science and Engineering* 13(1):37-75.

Wiers-Jenssen, Jannecke and Sverre Try. 2005. "Labour Market Outcomes of Higher Education Undertaken Abroad." *Studies in Higher Education* 30(6):681–705.

Wilson, Judith D., Elizabeth S. Adams, Helen Pp. Baouendi, William A. Marion, and Gayle J. YaveRbaum. 1988. "Computer Science Education in the People's Republic of China in the Late 1980s." *Communications of the ACM* 31(8):956–964.

Wong, Paul and Richard Nagasawa. 1991. "Asian American Scientists and Engineers: Is There A Glass Ceiling for Career Advancement?" *Chinese American Forum* 6(3):3-6.

Woo, Deborah. 1994. "Glass Ceilings and Asian Americans." Retrieved October 20, 2007 (http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1130&context=key_workplace).

Woo, Deborah. 2000. *Glass Ceilings and Asian Americans: The New Face of Workplace Barriers*. New York: Altamira Press.

Wright, Benjamin. 2009. “Employment, Trends, and Training in Information Technology.” *Occupational Outlook Quarterly* (*Bureau of Labor Statistics)* 53(1): 34-41.

Xie, Yu, and Kimberly Goyette. 2003. “Social Mobility and the Educational Choices of Asian Americans.” *Social Science Research* 32:467–498.

Xie, Yu, and Kimberly Goyette. 2004. *A Demographic Portrait of Asian Americans*. New York: Russell Sage and Population Reference Bureau.

Xie, Yu and Kimberlee A. Shauman. 1998. “Sex Differences in Research Productivity Revisited: New Evidence about an Old Puzzle.” *American Sociological Review* 63:847-70.

Xie, Yu and Kimberlee A. Shauman. 2003. *Women in Science: Career Processes and Outcomes*. Cambridge, MA: Harvard University Press.

Yusuf, Shahid and Kaoru Nabeshima. 2007. “Strengthening China’s Technological Capability.” Policy Research Working Paper. Retrieved November 20, 2008 (http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2007/08/09/000158349_20070809111012/Rendered/PDF/wps4309.pdf).

Zeng, Zhen and Yu Xie. 2004. “Asian-Americans’ Earnings Disadvantage Reexamined: The Role of Place of Education.” *American Journal of Sociology* 109(5):1075–1108.

Zuckerman, Harriet, Jonathan R. Cole, and John T. Bruer, eds. 1992. *The Outer Circle: Women in the Scientific Community*. New Haven, CT: Yale University Press.

NOTES

[1] Some authors classify this group (U.S.-born and foreign-born people of Asian origins) as Asian Americans (e.g. Woo 2000; Zeng and Xie 2004). Other studies address them as Asians (e.g. Tang 1997) or use Asians and Asian Americans interchangeably (Tang 2000). In this study, they are referred to as Asians, which is broader than Asian Americans. Asian Americans refer to those who were born in the U.S.

[2] In the CPST (2006) study, these fields are categorized as science, technology, engineering, and mathematics (STEM). The STEM fields in the CPST study includes biological and agricultural sciences, mathematics and computer sciences, physical sciences, psychology, social sciences, and engineering, which are the same broad fields included in NSB's (2008) report.

[3] Computer scientists defined by NSF and used in this study include computer and information scientists, computer support specialists, computer systems analysts, database administrators, network and computer systems administrators, network systems and data communications, computer engineers–software, other computer and information scientists, and postsecondary teachers in computer science. Secondary teachers in computer sciences, computer programmers, and technicians are not included in this category.

Engineers include aerospace, chemical, civil, architectural or sanitary, computer–hardware, electrical & electronics, industrial, mechanical, agricultural, environmental, Marine or naval, materials & metallurgical, environmental, mining and geological, nuclear, and biomedical engineers and bioengineers, and postsecondary teachers in engineering. Engineering technicians are not included in this category.
For more detailed description of jobs, please refer to the codebooks, in which NSF documents all the codes for the National Survey of College Graduates, 1993 and 2003. They are available for download together with raw data at the NSF website (www.sestat.nsf.gov). The variables used for a detailed description is OCPR (1993) and NOCPR (2003), and the variables used for broad categorization are OCPRMG (1993) and NOCPRMG (2003).

[4] The 1993 and 2003 did not cover some people who were foreign degreed in the U.S. Those who were not or poorly covered in 1993 include "individuals who were not residents of the United States as of 1 April 1990 (except those serving in the U.S. Armed Forces overseas) and who received a degree from a foreign degree-granting institution but not from a U.S. institution. Also not covered are those who were residents of the United States at the time of the 1990 decennial census and at that time had no degree but later received a degree from a foreign institution. Under the 1990s design, the foreign degreed are included in the SESTAT database only if they were included in the 1990 decennial census and already had at least a bachelor's degree." For more details, please refer to
http://www.nsf.gov/statistics/srs07201/content.cfm?pub_id=1716&id=2

Those who were not or poorly covered in 2003 include "(a) individuals eligible for the SESTAT integrated database who lived abroad as of the 2000 decennial census who later came to live in the United States and who did not earn a bachelor's or higher S&E degree from a U.S. institution after April 2000 and (b) individuals with only non-S&E degrees obtained after April 2000 who held S&E occupations in the survey reference period. In addition, individuals with only non-S&E degrees (who had obtained at least one degree before April 2000) who did not hold S&E occupations in 2003 but held such occupations in a later survey reference period would not be covered in the follow-up NSCG surveys after 2003." For more details, please refer to http://www.nsf.gov/statistics/srs07201/content.cfm?pub_id=1716&id=3.

[5] Asians refer to individuals with Asian origins, such as Asian Indians, Chinese, Filipinos, Japanese, Koreans, Singaporeans, Taiwanese, Thai, and Vietnamese. The NSF definition of Asia also includes the Middle East. However, the number of individuals with origins from the Middle East in this dataset is very small (less than 4% among Asian-born computer scientists and engineers in the 1993 and 2003 samples).

[6] The salary in the 1993 sample was top-coded at $150,000, and the actual amounts of salaries over $150,000 were not available. In the 2003 sample, the actual amounts of salaries were available, with a maximum of $565,172. However, to make salaries in 1993 and 2003 comparable, this study uses the variable “SALARP” in both data sets which top-coded salaries at $150,000. “SALARP” also rounded salaries at the unit of $1,000. For instance, if an individual’s actual salary was $20,936, the value of his or her “SALARP” was $21,000.

In 1993, the salaries of 81 engineers (70 whites, 1 Asian American, 6 U.S.-educated Asian immigrants, and 4 Asian-educated Asian immigrants) and 51 computer scientists (39 whites, 2 Asian Americans, 7 U.S.-educated Asian immigrants, and 3 Asian-educated Asian immigrants) were $150,000. In total, 0.07% of the engineers and 0.85% of the computer scientists in the 1993 sample had actual salaries at or over $150,000.

In 2003, the salaries of 130 engineers (106 whites, 4 Asian Americans, 17 U.S.-educated Asian immigrants, and 3 Asian-educated Asian immigrants) and 98 computer scientists (74 whites, 1 Asian Americans, 19 U.S.-educated Asian immigrants, and 4 Asian-educated Asian immigrants) were over and top-coded at $150,000. In total, 1.77% of the engineers and 1.42% of the computer scientists in the 2003 sample had their salaries top-coded.

[7] For more details, please refer to http://data.bls.gov/cgi-bin/cpicalc.pl. This study converts the 1993 salaries into 2003 dollar values to match the 2003 salaries.

[8] I exponentiate the coefficients of Asian race, nativity, or degree origin, if statistically significant, to get the percentage result [e.g., exp(-.0417)=.959]. This means that Asian highest degree at the .50 point leads to an earning disadvantage of 4.1% (1-.959).

[9] Some exceptions are India, Hong Kong, and Singapore, where a large share of, if not all, schools and universities use English as the language of instruction.